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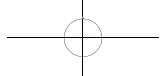
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Journal of Clinical and Nursing Research

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Journal of Clinical and Nursing Research (JCNR) is an international, peer reviewed and open access journal that seeks to promote the development and exchange of knowledge which is directly relevant to all clinical and nursing research and practice. Articles which explore the meaning, prevention, treatment, outcome and impact of a high standard clinical and nursing practice and discipline are encouraged to be submitted as original article, review, case report, short communication and letters.

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Practical Exploration of the “Six-Step” Situational Teaching Method in Operating Room Nursing Education

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Abstract: *Objective:* To explore the application effectiveness of the “Six-Step” Scenario-Based Teaching Method in operating room nursing education. *Methods:* Seventy nursing students undergoing clinical training in the operating room of a certain hospital from January 2024 to June 2025 were selected. They were randomly divided into an observation group ($n = 35$) and a control group ($n = 35$) using a random number table. The control group received traditional “mentor-apprentice” on-the-job training, while the observation group underwent the “six-step” scenario-based teaching method. The two groups were compared on final assessment scores, comprehensive competency, surgical nursing emergency response ability, and teaching satisfaction indicators. *Results:* The observation group achieved significantly higher final assessment scores (85.54 ± 5.05) than the control group (78.63 ± 4.75); After instruction, the observation group scored significantly higher than the control group in: mastery of basic duties and procedures (4.22 ± 0.30 vs. 3.98 ± 0.30), understanding of surgical nursing essentials (4.39 ± 0.19 vs. 3.98 ± 0.30), proficiency in surgical assistance (4.11 ± 0.33 vs. 3.98 ± 0.30), aseptic awareness (4.32 ± 0.24 vs. 3.98 ± 0.30), risk awareness (4.22 ± 0.17 vs. 3.98 ± 0.30), and occupational safety awareness (4.01 ± 0.23 vs. 3.98 ± 0.30). (4.01 ± 0.23), which were significantly higher than the control group’s scores (3.36 ± 0.28), (3.14 ± 0.27), (3.29 ± 0.24), (3.53 ± 0.36), (3.17 ± 0.25), and (3.51 ± 0.18), respectively. Students in the observation group scored significantly higher than the control group in emergency hands-on skills (24.53 ± 1.85 points), surgical coordination skills (27.65 ± 1.87 points), emergency coordination skills (25.34 ± 1.83 points), and patient condition observation skills (24.34 ± 1.79 points) were significantly higher than those of the control group (20.78 ± 1.74 points, 26.31 ± 1.95 points, 22.92 ± 1.69 points, and 21.58 ± 1.77 points, respectively). The satisfaction rate with operating room nursing education among students in the observation group (97.00%) was significantly higher than that in the control group (77.00%). All differences were statistically significant ($p < 0.05$). *Conclusion:* The “Six-Step” Scenario-Based Teaching Method effectively enhances operating room students’ mastery of theoretical knowledge, practical skills, and core comprehensive abilities, while significantly improving their teaching satisfaction. It warrants promotion and application in operating room nursing education.

Keywords: Six-step scenario-based teaching method; Operating room nursing; Nursing education; Practical exploration

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1. Introduction

Operating room nursing education is a critical component in cultivating qualified surgical nursing professionals. Traditional teaching methods primarily rely on “apprenticeship-style” shadowing, where students passively receive knowledge without sufficient opportunities for hands-on practice and scenario-based experiences. This disconnect between theory and practice hinders the flexible application of learned knowledge in real-world settings, particularly during complex surgical situations^[1]. Therefore, there is an urgent need to explore an efficient and practical teaching method for operating room nursing to significantly enhance teaching quality and cultivate high-caliber nursing professionals who can meet the demands of operating room work. Situational teaching is a pedagogical approach grounded in constructivist theory. It advocates creating scenarios that closely resemble real-world work environments during the learning process, enabling students to actively construct knowledge and develop competencies while solving authentic problems and completing real tasks^[2]. Existing research indicates this method demonstrates significant advantages in emergency and obstetric nursing education. Huang Yumin et al., through observing the application of a scenario-based teaching model using real cases combined with an OSCE evaluation system in emergency nursing clinical teaching, found this approach not only significantly enhances students’ theoretical knowledge but also substantially improves their clinical skills and overall professional competence^[3]. Yang Chanjuan et al. demonstrated through teaching experiments that applying scenario-oriented nursing teaching models in obstetric education significantly enhances students’ foundational theory and nursing practice levels, while promoting improvements in adaptability, problem analysis, teamwork, and communication skills^[4]. To investigate the effectiveness of scenario-based teaching in operating room nursing education, this study innovatively designed a six-step scenario-based teaching plan, comprising scenario creation, task-driven learning, role-playing, collaborative inquiry, process guidance, and summary evaluation, based on scenario learning theory and operating room workflow. The findings are reported as follows.

2. Materials and methods

2.1. General information

The study included 70 nursing students interning in the operating room of a certain hospital from January 2024 to June 2025. Participants were randomly assigned to an observation group (n = 35) and a control group (n = 35) using a random number table.

2.1.1. Inclusion criteria

- (1) Full-time undergraduate or vocational nursing students;
- (2) Six-month internship duration;
- (3) Voluntary participation in the study

2.1.2. Exclusion criteria

- (1) Cumulative leave exceeding one month during internship due to personal reasons;
- (2) Prior operating room work experience

2.1.3. Observation group

3 males, 32 females; age 20–24 years, mean (22.3 ± 1.2) years; 22 undergraduate students and 13 vocational

students. The control group comprised 2 males and 33 females; ages ranged from 20 to 23 years, with a mean age of (21.8 ± 1.1) years; 20 undergraduate students and 15 vocational students. Comparisons of general characteristics (gender, age, educational background) between the two groups showed no statistically significant differences ($p > 0.05$), indicating comparability.

2.2. Methods

Both groups used the same textbook for instruction, with identical course hours and assessment criteria.

2.2.1. Control group

Employed a traditional “mentor-apprentice” classroom teaching model. After entering the department, students learned by participating in routine surgical assistance alongside their mentors. The learning process primarily involved observation and imitation. Mentors provided ad hoc explanations and guidance based on the day’s surgical procedures, while students performed basic tasks such as instrument passing and inventory checks under mentor supervision.

2.2.2. Observation group

Employed a “six-step” scenario-based teaching method. Theoretical instruction followed three steps: “Project Initiation, Knowledge Construction and Exploration, Deepening and Application”. Practical training followed three steps: “Outcome Creation and Revision, Public Presentation and Evaluation, Summary and Reflection”.

(1) Step 1: Project initiation

Instructors design typical surgical scenarios based on real clinical cases. They present comprehensive nursing contexts to students through surgical videos and case materials, assigning core learning tasks for the scenario.

(2) Step 2: Knowledge construction and exploration

Students assume roles such as scrub nurse or circulating nurse based on task requirements. Collaboratively researching surgical procedures, instrument diagrams, and nursing essentials, they compile a list of theoretical knowledge and operational workflows needed for surgical assistance, thereby establishing an initial knowledge framework.

(3) Step 3: Deepening and application

Instructors act solely as facilitators, organizing students for preliminary tabletop simulations. Through pre-set critical questions, they guide students to apply previously constructed theoretical knowledge to solve simulated clinical problems, deepening understanding and preparing mindsets for subsequent hands-on training.

(4) Step 4: Outcome creation and revision

Upon entering the simulation operating room, students work in teams to perform role-playing within a high-fidelity scenario, collaborating to complete the entire workflow from preoperative preparation through intraoperative assistance to postoperative management. Throughout this process, team members continuously refine their coordination and techniques, ultimately producing a “practical outcome”.

(5) Step 5: Public presentation and evaluation

Following each scenario simulation, teams conduct public presentations. Students first deliver self-reflections and peer evaluations within their groups, explaining procedural rationale and identifying

areas for improvement. Subsequently, instructors provide systematic, structured feedback using the Core Competencies for Nursing (CIRN) framework to assess students' overall competency, highlighting strengths and weaknesses.

(6) Step 6: Summary and reflection

After the training concludes, students write reflection report based on the feedback received. They conduct an in-depth analysis of their gains and shortcomings in knowledge, skills, and attitudes, and formulate subsequent learning plans to achieve knowledge internalization and competency enhancement.

2.3. Observation indicators

(1) Final assessment scores

Upon completion of instruction, both student groups undergo unified evaluations in nursing theory, basic procedural skills, and specialty procedural skills. The total score is 100 points, with 30 points allocated to each section: nursing theory, basic procedural skills, and specialty procedural skills.

(2) Comprehensive competencies

Quantitatively assess students' mastery of fundamental job responsibilities and procedures, surgical nursing essentials, proficiency in surgical assistance, aseptic concepts, risk awareness, and occupational safety consciousness. Each competency is scored out of 5 points.

(3) Surgical emergency response capability

Compare emergency response capabilities during operating room practice between groups, encompassing emergency intervention, surgical coordination, emergency collaboration, and patient condition monitoring. Ten items are evaluated, each scored 1–3 points, totaling 30 points.

(4) Nursing satisfaction

A self-designed teaching satisfaction survey was used to assess satisfaction with teaching methods across groups. Options included "Very satisfied," "Satisfied," and "Dissatisfied". Students selected based on genuine feelings. Overall satisfaction rate = (Number of "very satisfied" + Number of "satisfied") / Total number of respondents \times 100%.

2.4. Statistical methods

Data analysis was performed using SPSS 22.0 statistical software. Quantitative data were expressed as mean \pm standard deviation ($\bar{x} \pm s$). Intergroup comparisons were conducted using *t*-tests. Qualitative data are expressed as rates (%). Intergroup comparisons were conducted using chi-square χ^2 tests. A *p* value < 0.05 was considered statistically significant.

3. Results

3.1. Comparison of course assessment scores between groups

Students in the observation group demonstrated significantly higher scores than the control group in nursing theory knowledge, basic procedural skills, specialized procedural skills, and overall assessment scores ($p < 0.05$), as shown in **Table 1**.

Table 1. Comparison of final assessment scores between groups ($\bar{x} \pm s$, points)

Group	Nursing theory	Basic operational skills	Specialized skills	Total score
Control group (n = 35)	22.25 \pm 1.07	23.32 \pm 1.14	33.06 \pm 2.54	78.63 \pm 4.75
Observation group (n = 35)	25.42 \pm 1.19	24.75 \pm 1.68	35.37 \pm 2.18	85.54 \pm 5.05
<i>t</i>	11.719	4.167	4.083	5.897
<i>p</i>	< 0.001	< 0.001	< 0.001	< 0.001

3.2. Comparison of comprehensive competency scores between the two groups

After the training, the observation group scored significantly higher than the control group in all dimensions, including mastery of basic job responsibilities and procedures, understanding of key surgical nursing points, proficiency in surgical assistance, aseptic concepts, risk awareness, and occupational protection awareness. The differences were statistically significant ($p < 0.05$), as shown in **Table 2**.

Table 2. Comparison of comprehensive competency scores between groups ($\bar{x} \pm s$, points)

Group	Mastery of basic job responsibilities and procedures	Mastery of key surgical nursing points	Proficiency in surgical procedure coordination	Sterility concept	Risk awareness	Occupational safety awareness
Control group (n = 35)	3.36 \pm 0.28	3.14 \pm 0.27	3.29 \pm 0.24	3.53 \pm 0.36	3.17 \pm 0.25	3.51 \pm 0.18
Observation group (n = 35)	4.22 \pm 0.30	4.39 \pm 0.19	4.11 \pm 0.33	4.32 \pm 0.24	4.22 \pm 0.17	4.01 \pm 0.23
<i>t</i>	12.398	22.399	11.889	10.802	20.547	10.128
<i>p</i>	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001

3.3. Comparison of surgical nursing emergency response capabilities between the two groups

After instruction, the observation group demonstrated significantly higher scores than the control group in emergency hands-on skills, surgical coordination ability, emergency coordination skills, and patient condition observation skills were significantly higher than those of the control group ($p < 0.05$), as shown in **Table 3**.

Table 3. Comparison of surgical nursing emergency response scores between groups ($\bar{x} \pm s$, points)

Group	Emergency hands-on skills	Surgical cooperation	Emergency coordination	Clinical observation
Control group (n = 35)	20.78 \pm 1.74	26.31 \pm 1.95	22.92 \pm 1.69	21.58 \pm 1.77
Observation group (n = 35)	24.53 \pm 1.85	27.65 \pm 1.87	25.34 \pm 1.83	24.34 \pm 1.79
<i>t</i> -value	8.735	2.934	5.748	6.486
<i>p</i> -value	< 0.001	0.004	< 0.001	< 0.001

3.4. Comparison of teaching satisfaction between groups

Students in the observation group demonstrated significantly higher satisfaction with operating room nursing education than those in the control group, with statistically significant differences ($p < 0.05$), as shown in **Table 4**.

Table 4. Comparison of teaching satisfaction between groups [n (%)]

Group	Very satisfied	Satisfied	Dissatisfied	Overall satisfaction
Control group (n = 35)	9 (26.00)	18 (51.00)	8 (23.00)	27 (77.00)
Observation group (n = 35)	15 (43.00)	19 (54.00)	1 (3.00)	34 (97.00)
χ^2				4.590
<i>p</i>				0.032

4. Discussion

Operating room nursing practice imposes exceptionally high standards on nurses' professional competence due to its stringent aseptic techniques, complex surgical care procedures, and demanding requirements for teamwork [5]. The quality of operating room nursing education is crucial in determining whether students can become qualified operating room nurses in the future. Therefore, during this period, it is essential to actively adopt scientific and effective teaching methods to ensure the effectiveness of clinical training, thereby effectively enhancing their theoretical knowledge, nursing skills, comprehensive competence, and emergency response capabilities in surgical care [6]. While the traditional "apprenticeship-style" shadowing model can transmit basic experience, its passive, fragmented, and observation-focused nature struggles to systematically cultivate the comprehensive competencies students need to handle complex surgical scenarios [7].

The "Six-Step" Scenario-Based Teaching Method is a structured instructional approach developed under constructivist theory guidance [8]. The "Six-Step" teaching method implemented in this pedagogical research study perfectly embodies this theoretical core through six interlinked steps: "Project Initiation, Knowledge Construction and Inquiry, Deepening and Application, Product Creation and Revision, Public Presentation and Evaluation, and Summary and Reflection". The study findings indicate that students in the observation group significantly outperformed the control group in all three major domains: nursing theory, basic procedures, and specialized procedures ($p < 0.001$). Scores for observation group students were significantly higher than those for the control group across all dimensions, including mastery of fundamental job responsibilities, surgical essentials, coordination proficiency, aseptic concepts, risk awareness, and occupational protection consciousness ($p < 0.001$). The improvement in emergency response skills, emergency coordination, and patient observation abilities among the observation group was significantly greater than that of the control group ($p < 0.001$). The observation group also demonstrated significantly higher satisfaction with operating room nursing education compared to the control group ($p < 0.05$).

Analysis attributes these outcomes primarily to the significant application advantages of the "Six-Step" Scenario-Based Teaching Method in operating room nursing education:

- (1) Through the "Knowledge Construction and Exploration" and "Deepening and Application" steps, the method effectively promoted students' deep understanding and retention of theoretical knowledge. The "Outcome Creation and Revision" step further transformed theoretical knowledge into stable, standardized operational skills, achieving an organic integration of theory and practice [9].
- (2) Role-playing and task-driven "collaborative inquiry" enabled students to personally experience the severe consequences of improper aseptic techniques, clearly understanding their responsibilities. This not only reinforced aseptic awareness but also further enhanced their mastery of operating room nursing

procedures and risk awareness^[10].

- (3) The “Six-Step” scenario-based teaching method, through pre-set critical questions and high-fidelity simulations, creates opportunities for students to repeatedly hone emergency decision-making and hands-on skills in a “protective” environment. This approach stimulates intrinsic learning motivation, ultimately yielding high teaching satisfaction.

5. Conclusion

In summary, the “Six-Step” Scenario-Based Teaching Method is a proven effective surgical nursing teaching approach that significantly enhances students’ theoretical knowledge, operational skills, comprehensive competence, and emergency response capabilities, while achieving exceptionally high teaching satisfaction.

Disclosure statement

The authors declare no conflict of interest.

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Synergistic Antidepressant Effects of Total Saikosaponins Combined with Volatile Oil of Cyperi Rhizoma in Mice Models Induced by Chronic Restraint plus Mild Stress

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Abstract: This study aimed to evaluate the antidepressant effects of the combined administration of total saikosaponins (SSA) and volatile oil of Cyperi Rhizoma (VO) using a mouse depression model induced by chronic restraint plus mild stress (CRMS), and to compare the effects with the traditional antidepressant fluoxetine. Male Kunming mice were subjected to 14-day CRMS modeling and then randomly divided into four groups: the combined treatment group (intraperitoneal injection of SSA 3.5 mg·kg⁻¹ + VO 35 mg·kg⁻¹), the fluoxetine treatment group (20 mg·kg⁻¹), the normal saline treatment group, and the non-model group. Drugs were administered continuously for 14 days. Depressive-like behaviors were assessed using the Forced Swimming Test (FST), Tail Suspension Test (TST), and Open-Field Test (OFT). The results showed that the absolute immobility time of mice in the CRMS model group was significantly prolonged in FST and TST. Combined administration of SSA and VO significantly improved depressive-like behaviors, restoring the absolute immobility time in FST and TST to levels close to the control group, with efficacy comparable to fluoxetine. This study confirms that the combination of SSA and VO exhibits antidepressant effects equivalent to fluoxetine in the CRMS model, providing experimental evidence for the further clinical development of this traditional Chinese medicine (TCM) compatibility.

Keywords: Total saikosaponins; Volatile oil of *Cyperi Rhizoma*; Combined administration; Depression; Chronic restraint plus mild stress

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1. Introduction

Major depressive disorder (MDD) is a mental illness characterized by persistent low mood, anhedonia, cognitive impairment, and various somatic symptoms. The global lifetime prevalence of MDD is as high as

19.6%, with more than 300 million patients worldwide and approximately 58 million in China (WHO, 2022) ^[1]. It is predicted that by 2030, MDD will become the leading cause of premature death and disability ^[2]. Although selective serotonin reuptake inhibitors (SSRIs) and serotonin-norepinephrine reuptake inhibitors (SNRIs) are widely used ^[3,4], 30%–50% of patients still suffer from treatment-resistant depression. Additionally, these drugs have drawbacks such as delayed onset (2–4 weeks), sexual dysfunction, gastrointestinal disorders, insomnia, and arrhythmia in the elderly ^[3]. Therefore, there is an urgent need to explore new therapeutic strategies with rapid onset, minimal side effects, and suitability for long-term use.

TCM, characterized by “multi-component, multi-target, and multi-pathway” effects, provides new ideas for the treatment of depression. In TCM, depression is categorized as “stagnation syndrome”, with the core pathogenesis of “liver qi stagnation” and the therapeutic principle of “soothing the liver and relieving stagnation”. The drug pair of Bupleuri Radix et Rhizoma and Cyperi Rhizoma is present in more than 60% of antidepressant compound prescriptions, such as Chaihu Shugan San recorded in *Jingyue Quanshu* (Complete Works of Jingyue). Bupleuri Radix et Rhizoma is slightly cold in nature and belongs to the liver meridian. Its main active components, saikosaponin A and D, exert antidepressant effects by upregulating the hippocampal BDNF-TrkB-CREB pathway ^[5], inhibiting NF- κ B-mediated neuroinflammation ^[6], and regulating the hypothalamic-pituitary-adrenal (HPA) axis function ^[7, 8]. Cyperi Rhizoma is neutral in nature, regulating qi and soothing the liver. Its volatile oil is rich in α -cyperone, cyperone, and sesquiterpene oxides, with multiple effects such as inhibiting acetylcholinesterase, enhancing 5-HTergic neurotransmission, and improving anxiety-like behaviors induced by chronic stress ^[8, 9]. Previous network pharmacology predictions by the research team indicated that saikosaponins and volatile oil of Cyperi Rhizoma act on 10 core targets including 5-HT_{1A}, BDNF, mTOR, and AChE, suggesting potential synergistic effects. However, systematic reports on the compatibility ratio, dosage window, preventive/therapeutic properties, and mechanism verification of the key active components of this drug pair are lacking. Bupleuri Radix et Rhizoma-Cyperis Rhizoma is a classic TCM pair for “soothing the liver and relieving stagnation”, widely used clinically in emotional disorders. Nevertheless, standardized experimental evidence for the synergistic antidepressant mechanism between its main active components—total saikosaponins (SSA) and volatile oil of Cyperi Rhizoma (VO)—is insufficient.

This study adopted the chronic restraint plus mild stress (CRMS) model, which has good face validity, construct validity, and predictive validity ^[10], and can simulate depression caused by psychosocial stress in humans ^[11]. Through behavioral, body weight, acute toxicity, and histological evaluations, this study systematically explored the optimal dosage, therapeutic and preventive effects of SSA + VO, and conducted a head-to-head comparison with the positive drug fluoxetine, providing experimental evidence for the modernization of this classic drug pair.

2. Materials and methods

2.1. Medicinal materials, reagents, and instruments

Cyperi Rhizoma decoction pieces were purchased from Bozhou, Henan (Batch No. 20230401). Volatile oil was extracted by steam distillation for 2.5 h according to Method A in the “Determination of Volatile Oil” appendix of the 2020 Edition of the Chinese Pharmacopoeia (Part IV), yielding a pale yellow volatile oil (yield 0.41%, d_{4}^{20} 0.981). GC-MS identification showed the main components as α -cyperone (18.7%), cyperone (14.2%), and cyperene (11.5%) (Supplementary Table S2). Total saikosaponins ($\geq 70\%$, containing 38% SS-A and 22% SS-

D) were purchased from Shanghai Yuanye Biotechnology Co., Ltd. (Batch No. Z30O11L129400). Fluoxetine hydrochloride was purchased from Shanghai Macklin Biochemical Technology Co., Ltd. (Cat. No. F830634).

2.2. Experimental animals and feeding conditions

SPF-grade male Kunming mice, 8 weeks old, weighing 20–25 g, were provided by Guangdong Provincial Medical Experimental Animal Center [SCXK (Guangdong) 2022-0002]. After 7 days of adaptive feeding, mice were raised at room temperature ($22\pm 2^{\circ}\text{C}$), humidity (45–55%), and a 12 h light-dark cycle, with free access to food and water. The experiment was approved by the Animal Ethics Committee of Jiaying University (JYAE2023-03).

2.3. Extraction and content determination of volatile oil

Referring to the pharmacopoeia method: 100 g of crushed Cyperi Rhizoma was soaked in 3 times the volume of water for 18 h, placed in a 1000 ml round-bottomed flask, connected to a volatile oil determination apparatus, and distilled at a gentle boil until no further increase in oil volume (approximately 5 h). The volatile oil was collected, centrifuged at 13000 r/min for 5 min, and the upper oil phase was stored at 4°C in the dark.

2.4. CRMS modeling protocol

On the first day, mice were restrained for 2 h, with the restraint time increased by 2 h daily until reaching 8 h, which was then maintained. Meanwhile, one mild stressor was randomly applied daily: ① 16 h fasting and water deprivation; ② wet bedding; ③ cage tilted at 45° ; ④ day-night reversal. Modeling was conducted continuously for 14 days, with a success rate $>90\%$ ($\geq 40\%$ increase in FST immobility time).

2.5. Grouping and administration

Phase I: Dosage Exploration ($n=24$)

Three dosage combinations were set according to 1/10, 1/20, and 1/40 of LD_{50} : SSA 7, 3.5, 2.3 $\text{mg}\cdot\text{kg}^{-1}$ + VO 70, 35, 17.5 $\text{mg}\cdot\text{kg}^{-1}$. Deaths and skin stiffness occurred in the high-dose group (7+70) from day 7, while the medium-dose group (3.5+35) showed no abnormalities within 14 days and optimal behavioral performance, which was determined as the dosage for subsequent experiments.

Phase II: Therapeutic Experiment (Post-CRMS, $n=36$)

After modeling, mice were randomly divided into four groups: ① Control + normal saline (Group C); ② Model + normal saline (containing 6.95% ethanol vehicle) (Group M); ③ Model + fluoxetine 20 $\text{mg}\cdot\text{kg}^{-1}$ (Group MF); ④ Model + SSA + VO (3.5+35 $\text{mg}\cdot\text{kg}^{-1}$) combined administration (Group CD). Drugs were administered once daily for 14 consecutive days.

2.6. Behavioral tests

(1) Forced Swimming Test (FST)

The test was conducted in buckets (height 30 cm, width 12 cm) filled with 22 cm deep water. Four mice could be tested simultaneously, separated by opaque partitions. In this test, the time when mice ceased struggling, floated with only slight limb movements to keep their heads above water was defined as absolute immobility time. Longer immobility time indicated more severe depression.

(2) Tail Suspension Test (TST)

Mice were gently removed from cages, and their tails were fixed with medical adhesive tape 1 cm from the tip to avoid additional stress. The monitoring index was absolute immobility time: the time when animals ceased struggling and remained vertically suspended motionless. Longer immobility time indicated more severe depression.

(3) Open-Field Test (OFT)

The test was performed in square boxes (bottom diameter 47.5 cm, wall height 47.6 cm), with four boxes used simultaneously. Total activity distance reflected the spontaneous activity level and vitality of mice, while central activity distance indicated stronger desire to explore new environments and lower anxiety levels.

All experiments were recorded and analyzed using Smart 3.0 professional behavioral software. The monitoring indices for FST and TST were absolute immobility time within 5 min, and those for OFT were total activity distance and central activity distance.

2.7. Statistical analysis

SPSS 25.0 software was used for statistical analysis of experimental data. Multiple group comparisons were performed using analysis of variance (ANOVA) followed by LSD post-hoc test. A p -value < 0.05 was considered statistically significant.

3. Results

3.1. FST and TST results

As shown in **Figure 1A** (FST results), compared with Group C (71.67 ± 9.43), the absolute immobility time of Group M (108.60 ± 14.18) was significantly increased, with a statistically significant difference. Compared with Group M, the absolute immobility time of Group CD (71.66 ± 8.73) and Group MF (72.75 ± 9.21) was significantly reduced, with statistically significant differences, and the immobility time of Group CD was comparable to that of Group MF. No significant difference in absolute immobility time was observed between Group CD, Group MF, and Group C. In summary, combined administration of SSA + VO reduced the absolute immobility time of CRMS model mice, with effects equivalent to fluoxetine.

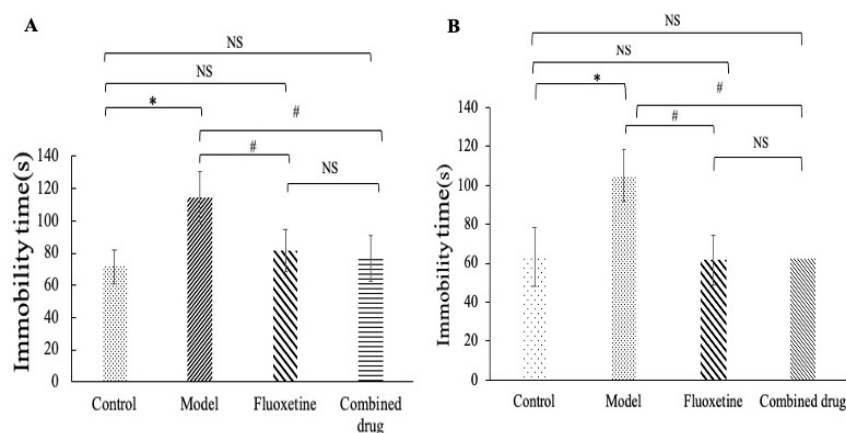


Figure 1. FST and TST tests after combined drug treatment

Note: * indicates $p < 0.05$ compared with Group C; # indicates $p < 0.05$ compared with Group M; NS indicates no significance.

As shown in **Figure 1B** (TST results), compared with Group C (63.19 ± 10.53), the absolute immobility time of Group M (104.97 ± 15.12) was significantly increased, with a statistically significant difference. Compared with Group M, the absolute immobility time of Group CD (62.57 ± 12.69) and Group MF (61.59 ± 13.46) was significantly reduced, with statistically significant differences, and the immobility time of Group CD was comparable to that of Group MF. No significant difference in absolute immobility time was observed between Group CD, Group MF, and Group C. In summary, combined administration of SSA + VO reduced the absolute immobility time of CRMS model mice, with effects equivalent to fluoxetine.

3.2. Open-field test (OFT) results

As shown in **Figure 2** (OFT results), there was no significant difference in total activity distance among the four groups. However, regarding central activity distance, compared with Group C (363.19 ± 12.53), the central activity distance of Group M (224.87 ± 17.32) was significantly reduced, with a statistically significant difference. Compared with Group M, the central activity distance of Group CD (330.59 ± 15.66) and Group MF (370.22 ± 14.69) was significantly increased, with statistically significant differences, and the central activity distance of Group CD was comparable to that of Group MF. No significant difference in central activity distance was observed between Group CD, Group MF, and Group C. In summary, combined administration of SSA + VO significantly increased the central activity distance of the model group, with effects equivalent to fluoxetine.

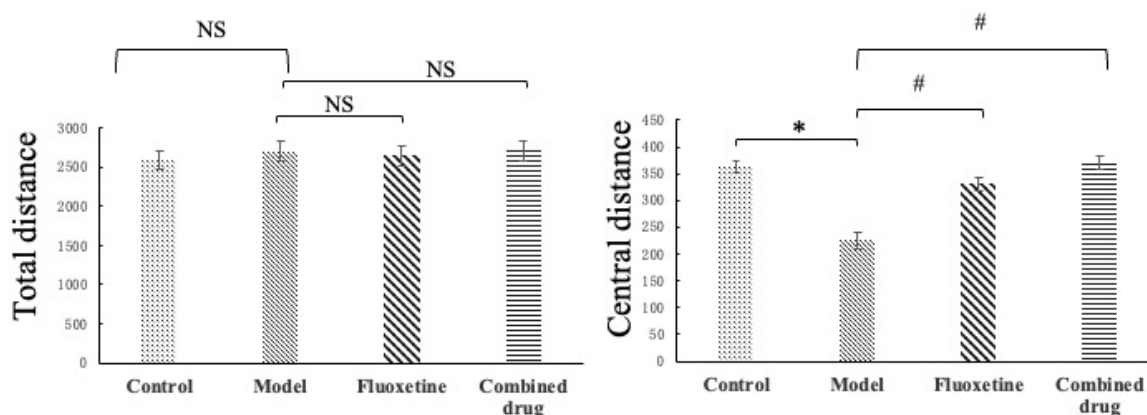


Figure 2. OPT test after combined medication treatment

Note: * indicates $p < 0.05$ compared with Group C; # indicates $p < 0.05$ compared with Group M; NS indicates no significance.

4. Discussion

This study is the first to systematically evaluate the antidepressant effects of the combination of SSA and VO in a mouse model of chronic restraint plus mild stress (CRMS). Behavioral tests (FST, TST, and OFT) showed that combined administration of SSA and VO restored the absolute immobility time or central activity distance of CRMS model mice to normal levels, with efficacy equivalent to the clinical first-line antidepressant fluoxetine ($20 \text{ mg} \cdot \text{kg}^{-1}$). This finding provides modern experimental evidence for the classic liver-soothing and stagnation-relieving drug pair “Bupleuri Radix et Rhizoma-Cyperis Rhizoma” and suggests the potential of multi-

component botanical drugs to replace chemical drugs in the intervention of depression.

The synergistic effects of SSA and VO may affect the “monoamine-neurotrophic-cholinergic” network. First, saikosaponin A and D in SSA have been confirmed to activate the hippocampal mTORC1-PSD95 signaling cascade within 6 hours, rapidly increasing postsynaptic density protein levels, thereby reversing synaptic atrophy induced by chronic stress ^[7]. In this study, the SSA + VO group showed antidepressant effects equivalent to fluoxetine after 14 days of single daily administration, consistent with the above “rapid onset” finding. Second, α -cyperone, abundant in VO, can enhance GABAA receptor function, reduce excessive excitation of the basolateral amygdala, and alleviate anxiety-like behaviors ^[12]; meanwhile, VO can inhibit acetylcholinesterase activity, reduce acetylcholine decomposition, thereby improving stress-related cognitive rigidity ^[13, 14]. In the OFT, we observed that SSA + VO significantly increased central activity distance, suggesting dual anti-anxiety and antidepressant properties, consistent with the cholinergic regulatory effect of VO. Third, the joint upregulation of the BDNF-TrkB pathway by both components is supported by proteomic evidence: Gurtoo et al. found that BDNF was the most significantly elevated differential protein in the serum of hypoxic-ischemic neonates ^[5], and SS-A enhances neuroplasticity precisely through the TrkB receptor ^[5,15]. Therefore, SSA and VO affect the “monoamine-neurotrophic-cholinergic” three-dimensional network at the molecular level, synchronously alleviating emotional, cognitive, and somatic symptoms, and making up for the deficiency of fluoxetine’s single target.

However, this study has the following limitations: first, only male mice were used, lacking data on gender differences; second, although the behavioral experimental results are sufficient and repeatedly verified, serum or hippocampal levels of 5-HT, DA, BDNF, and AChE were not detected, and the mechanism still needs verification by ELISA or Western blotting. Finally, although CRMS can simulate psychosocial stress, it lacks direct indicators of anhedonia, a core symptom of human depression. In subsequent studies, the sucrose preference test can be combined to further confirm the improvement of reward dysfunction.

In conclusion, the combination of SSA and VO exhibits antidepressant effects equivalent to fluoxetine with higher safety in the CRMS model. Its “multi-component, multi-target, multi-pathway” characteristics provide new ideas for overcoming the shortcomings of traditional monoamine drugs. Future research should further explore the molecular mechanisms and optimize oral formulations, and promote early intervention clinical trials in high-risk populations to realize the modernization and international promotion of this classic drug pair.

5. Conclusions

The chronic restraint plus mild stress model can stably induce depressive-like behaviors in mice, suitable for evaluating antidepressant efficacy.

The combination of SSA (3.5 mg·kg⁻¹) and VO (35 mg·kg⁻¹) can improve depressive-like behaviors in CRMS model mice, with effects equivalent to fluoxetine.

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Disclosure statement

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Clinical Guideline for Cleansing and Antisepsis in Chronic Wounds

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Abstract: This guideline summarizes evidence-based recommendations for cleansing and antisepsis in chronic wounds. It defines target populations, assessment and decision frameworks, preferred cleansing solutions and pressures, indications and limits for antiseptics, biofilm-oriented strategies, pain control, and adaptations for high-risk patients and low-resource settings. The aim is to optimize wound bed preparation, protect viable tissue, reduce infection and iatrogenic injury, and standardize outpatient and home-care practice.

Keywords: Chronic wounds; Wound cleansing; Antisepsis; Irrigation solutions; Wound biofilm

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1. Introduction

In the absence of unified protocols, cleansing and antisepsis of chronic wounds are often determined by individual experience or departmental habits, leading either to overtreatment or undertreatment ^[1]. This guideline focuses specifically on cleansing and antisepsis in chronic wound care. Based on current evidence and expert consensus, it clarifies indications and limitations of commonly used rinsing solutions and antiseptics, defines stage- and wound-type-specific strategies, and emphasizes procedural pain control and patient comfort. The aim is to provide a practical, reproducible, and auditable framework that improves healing efficiency and patient experience while maintaining safety ^[2].

2. Scope and target population

This guideline applies to cleansing and antisepsis in chronic wounds of various etiologies, including but not limited to: Diabetic foot ulcers; Venous, arterial, and mixed arterial–venous leg ulcers; Pressure injuries of any stage; Radiation ulcers; Postoperative non-healing wounds; Chronic infectious wounds. The primary focus is cleansing and local antimicrobial/antiseptic management during routine and procedural dressing changes in adult patients. Recommendations may be extrapolated to adolescents or older adults with appropriate clinical judgment ^[3]. Ulcers directly caused by primary or metastatic malignancy, where definitive treatment depends on oncologic management. Such conditions should follow relevant emergency or specialty pathways ^[3].

3. Role of cleansing and antisepsis in chronic wounds

Chronic wounds are characterized by persistent inflammation, microcirculatory disturbance, and imbalance between tissue destruction and repair. Locally, necrotic tissue, fibrous slough, and high-burden microbiota (including biofilms) coexist with extracellular matrix degradation and impaired fibroblast and keratinocyte function, causing the wound to remain locked in a chronic inflammatory state ^[4].

From a pathophysiologic standpoint, wound cleansing is the first key step in “resetting” the microenvironment. It should be regarded as a therapeutic intervention, not merely washing the wound ^[3]. Its effect depends on both the physicochemical properties of the solution and the method and pressure of irrigation. In routine and most procedural dressing changes, isotonic solutions are preferred, with the main goal being physical removal of contaminants and devitalized material, rather than complete sterilization of the wound surface, which is neither feasible nor necessary ^[5].

4. Assessment and decision-making framework

Before any cleansing or antiseptic procedure, a structured assessment should be performed to clarify the purpose and potential risks of that particular intervention ^[6]. At minimum, four domains should be evaluated: Wound type and etiology. DFU, VLU, arterial or mixed ulcer, pressure injury. Different etiologies imply differing perfusion status and infection risk. Local status and pain-including exudate volume, proportion of necrotic or sloughy tissue, exposure of bone, tendon or vessels, plus resting and procedural pain levels ^[7]. Clinical tools such as NERDS/STONEES or BWAT may be used to semi-quantify infection and wound status, as supportive-not sole-decision bases. Standardized pain scores (NRS/VAS) help determine the need for pre-emptive analgesia and to tailor manipulation intensity ^[8].

5. Therapeutic principles and pathways

Overall principles include: Cleansing first, antisepsis as adjunct; Physiological safety as prerequisite, wound bed preparation as goal; Avoid excessive irritation, over-frequent cleansing, and high-pressure irrigation; Integrate cleansing into a TIME-based wound bed preparation strategy ^[9].

Isotonic solutions are first-line. Normal saline (0.9% NaCl) is widely used; in settings with reliable water quality, running tap water is equally safe and effective for most chronic wounds, especially in outpatient or home care ^[10]. In operating rooms or for profoundly immunocompromised/high-risk patients, saline or dedicated irrigation solutions are preferable.

Solutions containing alcohol, high-concentration tincture of iodine, or strong oxidizers should not be used repeatedly as routine rinsing liquids due to cytotoxicity ^[11]. For critically colonized wounds or those with strong suspicion of biofilm, short-term use of low-toxicity antimicrobial solutions-such as weakly acidic electrolyzed water, polyhexamethylene biguanide (PHMB), or hypochlorous acid-may be considered as part of a comprehensive regimen, but should not become chronic, long-term substitutes for isotonic cleansing ^[12].

Irrigation pressure is decisive for tissue safety. Low-to-moderate pressure irrigation is recommended to achieve adequate mechanical removal of debris while avoiding damage to granulation tissue and fragile neovessels ^[13]. In practice, this can be achieved with a syringe plus irrigation tip, gravity-drip irrigation, or gentle shower-type rinsing, adjusted to wound size, location, and patient tolerance. Special care should be taken to avoid direct high-pressure impact on the wound edge and any exposed tendon, bone, or major vessel.

Indications for topical antiseptics should be strictly defined. Recommended situations include: Clearly infected chronic wounds, especially those at high risk of anaerobic or multidrug-resistant infection ^[14]. Short-term local preparation before surgery. Immunosuppressed or severely metabolically compromised patients with heavy contamination/necrosis and high systemic infection risk ^[15].

Common agents include povidone-iodine, PHMB, silver-containing products, hydrogen peroxide and hypochlorous-based solutions. Regardless of choice, the following principles apply: Use antiseptics short-term, with limited field and clear exit strategy. Once infection is controlled and exudate improved, return promptly to isotonic cleansing. Adhere strictly to recommended concentrations, contact times, and frequencies in product labeling and guidelines ^[16].

Management should combine mechanical disruption sharp or mechanical debridement, careful curettage with short-term use of anti-biofilm solutions and dressings. One practical pattern is intermittent intensive cleansing plus daily maintenance cleansing: on designated intensive days, perform more thorough mechanical removal and antimicrobial treatment; on other days, maintain gentle isotonic cleansing and moisture balance ^[17].

Cleansing and antisepsis strategies must be adapted to specific populations and environments ^[18]. For diabetic foot and ischemic limbs, local tissues have low tolerance and high risk of ischemia and gangrene ^[19]. Tools and processes should be simplified, with strong emphasis on hand hygiene, environmental cleanliness, and patient/caregiver education to maximize safety under constrained conditions ^[20].

6. Follow-up and outcome evaluation

Key observational parameters include, wound area and trajectory of change $\geq 30\%$ reduction at 4 weeks may be used as a phase-efficacy threshold. Process quality indicators include: appropriate choice of cleansing solution and antiseptic according to the guideline; standardized irrigation pressure and technique; and assessment and management of procedural pain. Safety indicators include bleeding or excessive dryness caused by over-aggressive cleansing, and contact dermatitis, allergy, or delayed healing secondary to frequent antiseptic use.

7. Summary of recommendations (OCEBM A–D, Delphi Consensus)

Table 1 summarizes the key evidence-based recommendations for wound cleansing and antisepsis. It presents the recommendation strength (A–C) based on the Oxford Centre for Evidence-Based Medicine (OCEBM) levels and the consensus agreement rate from a Delphi process.

Table 1. Recommendation strength (A–C) reflects evidence quality, clinical benefit, safety, and feasibility

No.	Summary recommendation	Evidence level (OCEBM)	Strength	Delphi agreement
R1	For most chronic wounds, routine cleansing with normal saline or potable tap water is recommended; long-term use of highly cytotoxic antiseptics as standard irrigation fluid should be avoided.	1B	A	94%
R2	Before cleansing, perfusion, infection status, and pain should be systematically assessed; patients with moderate–severe pain should receive pre-emptive analgesia and, when appropriate, sedation.	2B	A	92%
R3	Low-to-moderate irrigation pressure (around 4–8 psi) should be used to reduce trauma to granulation tissue and neovessels; high-pressure “water-jet”-type irrigation is not recommended.	2C	B	90%
R4	Topical antiseptics should be used only short-term in clearly infected wounds or high-risk hosts with heavy contamination/necrosis; once infection is controlled, care should revert promptly to isotonic cleansing.	2C	B	88%
R5	For suspected biofilm and stalled healing, combined mechanical debridement plus anti-biofilm solutions/dressings is recommended rather than cleansing alone.	3B	B	87%
R6	In DFU and severely ischemic limbs, low temperature and high-force irrigation should be avoided; cleansing plans should be optimized after vascular evaluation and, where indicated, revascularization.	3C	B	85%
R7	Cleansing and antisepsis should be embedded in a multidisciplinary care pathway and coordinated with debridement, NPWT, surgical interventions, and dressing strategies.	3C	B	90%
R8	In outpatient and home-care settings, standardized operating procedures and patient education programs should be established to improve cleansing quality and adherence.	4	C	84%

8. Future directions and updating plan

High-quality evidence regarding long-term safety and healing impact of different cleansing solutions (tap water, saline, and specialized agents) and antiseptics in chronic wounds remains limited. Optimal combinations of anti-biofilm strategies and cleansing frequency also require prospective validation. This guideline encourages the establishment of multicenter databases of real-world cleansing practices and outcomes, and the conduct of randomized trials and prospective cohorts to refine recommendations.

Disclosure statement

The authors declare no conflict of interest.

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Evidence-Based Nursing Optimization for Catheter Tip Positioning in PICC Insertion in Patients with Persistent Left Superior Vena Cava

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Abstract: *Objective:* To explore the evidence-based nursing optimization strategy for catheter tip positioning during peripherally inserted central catheter (PICC) insertion in patients with persistent left superior vena cava (PLSVC). *Methods:* For one ovarian cancer patient with PICC malposition in the coronary sinus (CS) due to PLSVC, multi-modal imaging techniques were integrated to accurately locate the catheter tip. The catheter position was adjusted based on evidence (withdrawing 5 cm), and a standardized nursing process was established, including personalized health education, catheter fixation and displacement monitoring, complication monitoring, establishment of a specialized disease information archive system, and formulation of a follow-up plan. *Results:* The catheter tip was successfully withdrawn from the coronary sinus (at the T8 level) to the middle and lower part of the PLSVC (at the T6 vertebral level), and the catheter functioned normally after adjustment. No complications such as arrhythmia or thrombosis occurred during the 332-day chemotherapy period. *Conclusion:* The PICC tip in PLSVC patients should be positioned in the middle and lower part of the PLSVC (at the T5–T7 vertebral level). This new standard can effectively avoid CS-related complications. The integration of multi-modal imaging techniques and evidence-based nursing management are key to ensuring safe infusion.

Keywords: Persistent left superior vena cava; Peripherally inserted central catheter; PICC; Nursing

Online publication: Dec 31, 2025

1. Introduction

Persistent left superior vena cava (PLSVC) is a common congenital anomaly of systemic venous development, with an incidence of approximately 0.3–0.5% in the general population ^[1]. When it coexists with the right superior vena cava, it is called double superior vena cava (DSVC). The incidence of PLSVC is significantly higher in patients with congenital heart disease, reaching 2–10% ^[2]. Most individuals with PLSVC have no obvious clinical symptoms and are usually accidentally discovered during central venous catheter insertion, cardiac pacemaker implantation, or cardiothoracic surgery. In approximately 90% of cases, PLSVC drains into the right atrium

through the dilated coronary sinus (CS) ^[3]. This anatomical variation poses challenges for left upper extremity PICC insertion. If the catheter tip mistakenly enters the coronary sinus, infusion of high-concentration or irritating chemotherapeutic drugs may lead to serious consequences. From November 2021 to August 2025, our department completed more than 1,300 PICC insertions, among which 1 PLSVC patient was identified. This article aims to detail the diagnosis, treatment, and nursing process of this case, in order to provide references for peers.

2. Case report

2.1. Basic information

(a) Patient

Female, 55 years old.

(b) Chief complaint

“Postoperative chemotherapy for ovarian cancer”

(c) Diagnosis

Ovarian malignant tumor (clear cell carcinoma, Stage IV). Admitted to the hospital on July 10, 2024, scheduled to receive the first cycle of TC regimen (paclitaxel + carboplatin) chemotherapy.

To establish a long-term venous access, the patient underwent ultrasound-guided PICC insertion in the outpatient department of our hospital.

2.2. Pre-insertion assessment

2.2.1. Clinical assessment

The patient was in good general condition with stable vital signs, clear consciousness, and high compliance. Preoperative examinations such as blood routine, coagulation function, and electrocardiogram were all within normal ranges, and there were no contraindications to PICC insertion. The informed consent was signed.

2.2.2. Vascular assessment

The patient reported a preference for the right lateral decubitus position. To improve sleep quality and comfort, the left upper extremity was selected for catheter insertion after communication. Ultrasound assessment showed that the left basilic vein had a good inner diameter, smooth vessel wall, unobstructed blood flow, no thrombosis, and no obstacles in the puncture path, meeting the puncture conditions.

2.2.3. Body surface measurement

The patient was unknown to have a double superior vena cava before catheter insertion. The length was measured from the intended puncture point along the venous direction to the right sternoclavicular joint and then downward to the third intercostal space, with the measured catheter insertion length being 43 cm. The arm circumference of both upper extremities (10 cm above the elbow crease) was 27 cm, showing no difference.

2.3. Insertion process and tip localization

2.3.1. Puncture and catheter advancement

A 4F single-lumen PICC catheter (Bard, USA) was used, and successful puncture was performed in the left upper arm basilic vein under ultrasound guidance. When the catheter was advanced to 39 cm, “elastic resistance”

different from the conventional resistance was encountered, rather than the hard resistance caused by touching the vessel wall or venous valve. After adjusting the abduction angle of the patient's left arm to 60 degrees, the catheter could be slowly advanced to the predetermined length of 43 cm. After the operation, blood return was unobstructed, there was no resistance when flushing with normal saline, and the patient had no complaints of discomfort such as chest tightness or palpitations.

2.3.2. Preliminary imaging localization (chest X-ray)

Due to the abnormal hand feeling during intraoperative catheter advancement, a bedside chest posteroanterior X-ray examination was performed immediately after catheter insertion. The image showed abnormal course of the PICC catheter: instead of traveling to the right along the conventional path from the left subclavian area, the catheter descended vertically along the left edge of the aortic arch and the left contour of the heart, with the tip reaching deep into the cardiac contour, and its projected position was at the level of the 8th thoracic vertebra (T8). This characteristic image highly suggested the presence of a persistent left superior vena cava (PLSVC).

2.3.3. Accurate imaging localization and diagnosis (chest contrast-enhanced CT)

To clarify the exact relationship between the catheter tip and cardiac structures and determine whether it had entered the coronary sinus, after urgent communication with the attending physician, the patient was arranged to undergo a chest contrast-enhanced CT scan (see **Figure 1**). The results of CT angiography clearly diagnosed double superior vena cava malformation with the presence of PLSVC. The right superior vena cava was approximately 6 cm in length and 11 mm × 13 mm in diameter, while the left superior vena cava was approximately 7 cm in length and 15 mm × 18 mm in diameter. The PLSVC descended along the left side of the thoracic cavity, finally draining into the significantly dilated coronary sinus, which then enters the right atrium through the opening of the coronary sinus. CT showed that the PICC catheter tip had entered the coronary sinus along this path and then into the right atrium, with the tip located at the level of the T8 vertebra.

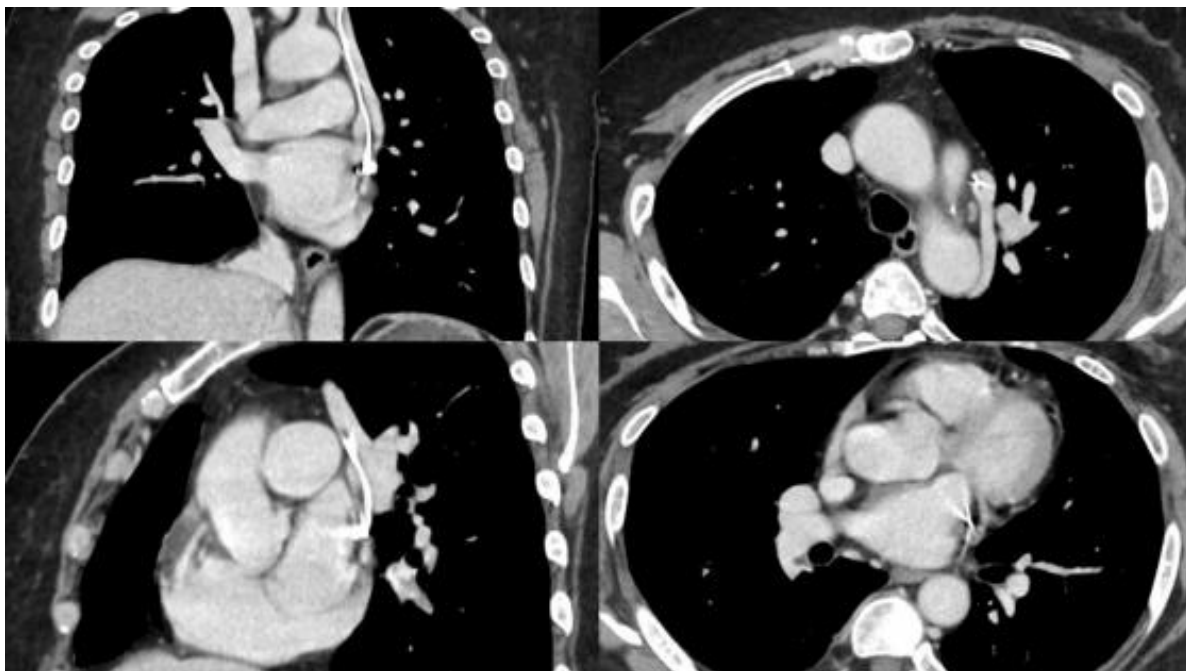


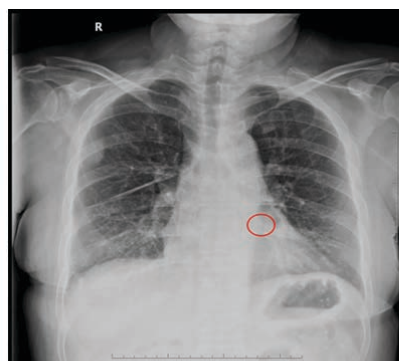
Figure 1. The catheter tip enters the right atrium.

2.3.4. Evidence-based adjustment of catheter tip position

Studies have indicated that for patients with a persistent left superior vena cava (PLSVC), the optimal position for the tip of a peripherally inserted central catheter (PICC) should be in the middle-lower segment of the PLSVC itself (not fixed at the T6–T7 level)^[4,8], i.e., before the entrance of the coronary sinus. This position not only ensures the blood flow dilution effect of central venous infusion but also minimizes stimulation and damage to the coronary sinus and intracardiac structures. If the catheter tip is placed inside the coronary sinus, the risks are extremely high, including as follow.

- (1) Direct stimulation of the coronary sinus wall by chemotherapeutic drugs, which may lead to chemical phlebitis and arrhythmia
- (2) Alteration of the pressure inside the coronary sinus, inducing angina pectoris, myocardial ischemia, or even myocardial infarction
- (3) Increased risk of coronary sinus thrombosis

Based on the CT positioning results; the catheter position was adjusted immediately. Under sterile conditions, the PICC was withdrawn 5 cm outward. An immediate bedside chest radiograph was performed, confirming that the catheter tip had retracted to the level of the T6 vertebra, located in the middle-lower part of the PLSVC. To avoid radiation exposure from CT scans for the patient, a bedside echocardiogram was also requested. Both the apical four-chamber view and subxiphoid two-chamber view of the echocardiogram showed no PICC echo in the right atrium, indicating that the catheter tip was away from the high-risk coronary sinus area. After adjustment, the catheter length was 38 cm, and both blood return and flushing functions of the catheter were normal (see **Figure 2**).



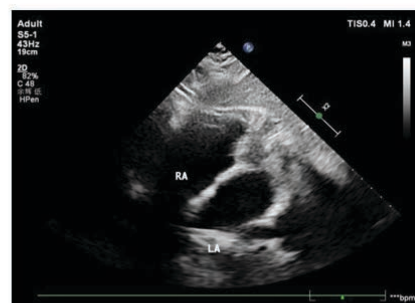
The catheter tip is located at the T8 level.



The catheter tip is located at the T6 level.



Apical four-chamber view shows no visualization of the PICC tip.



Subxiphoid two-chamber view shows no visualization of the PICC tip.

Figure 2. The location of catheter and PICC tip.

2.4. Catheter retention criteria for persistent left superior vena cava (PLSVC)

Based on the venous drainage site and associated malformations, PLSVC is clinically classified into 4 types: Type I (accounting for 90%) refers to PLSVC draining into the right atrium via the coronary sinus, with normal hemodynamics and no shunt; Type II PLSVC is based on Type I, with a shunt between PLSVC and the left atrium, resulting in partial right-to-left shunting; Type III PLSVC drains directly into the left atrium, with right-to-left shunting; Type IV PLSVC is directly connected to the left pulmonary vein. Anatomically, Type I has normal function due to unchanged hemodynamics; the other three types, however, have right-to-left shunting, causing part of the venous blood to flow into the left atrium and mix with oxygenated blood, resulting in a congenital malformation similar to anomalous pulmonary venous connection. After the catheter tip enters the persistent left superior vena cava, the decision on whether to retain the catheter is made based on the results of relevant examinations to determine the type, course, and whether the lumen diameter of the left superior vena cava is appropriate. Therefore, catheters can be retained for Type I PLSVC (draining to the right atrium) with a lumen diameter ≥ 15 mm, cases where the lumens of the bilateral superior vena cava are similar, isolated PLSVC, and those with a large lumen diameter confirmed by ultrasound^[4]. In this case, the patient was confirmed by CT to have Type I PLSVC with a left lumen size of 15 mm \times 18 mm, meeting the safety standards.

3. Core nursing strategies

3.1. Integrated application of multimodal imaging technologies in diagnosis and localization

3.1.1. Chest X-ray

It is the most basic and rapid preliminary screening tool. If an abnormal path of the catheter (inserted on the left side) running vertically downward along the left edge of the mediastinum is detected, further examinations should be initiated immediately.

3.1.2. Contrast-enhanced CT

It is the gold standard for confirming the anatomical course of persistent left superior vena cava (PLSVC) and accurately evaluating the three-dimensional spatial relationship between the catheter tip, coronary sinus, and right atrium^[5]. In this case, CT examination played a key role in confirming the diagnosis and guiding subsequent adjustments, with the catheter tip placed in the middle and lower part of PLSVC (T5–T7).

3.1.3. Intracavitary electrocardiogram (IC-ECG) technology

Studies have confirmed that intracavitary ECG (IC-ECG) is the gold standard for real-time catheter placement and localization^[6]. During catheterization, the position of the catheter tip in the middle and lower part of PLSVC can be judged in real time by monitoring changes in the P wave morphology (broad and inverted P wave) on the electrocardiogram.

3.1.4. Ultrasound

In addition to guiding puncture, cardiac ultrasound is also of great value in diagnosing PLSVC. By injecting microbubble contrast agent into the left arm vein, the dilated coronary sinus can be observed to opacify first, followed by the entry of bubbles into the right atrium, this is a typical sign for diagnosing PLSVC complicated with coronary sinus drainage. In this case, bedside ultrasound showed no PICC (peripherally inserted central

catheter) tip in multiple cardiac cavity sections, ensuring that the catheter tip was far away from the venous sinus.

3.1.5. Electromagnetic navigation & intracavitary electrocardiogram (EN-IC-ECG)

The EN-IC-ECG localization technology is an innovative PICC placement method. By integrating real-time position tracking of the electromagnetic navigation system and P wave morphology monitoring of intracavitary electrocardiogram, it significantly improves the accuracy and safety of catheter tip localization. The electromagnetic navigation technology uses the principle of electromagnetic fields to construct a 3D model of the catheter's path, which can dynamically display the position and direction of the catheter tip in the blood vessel in real time. Once the system detects leftward displacement of the catheter (into PLSVC) or deviation from the predetermined path (such as accidental entry into the brachiocephalic vein or internal jugular vein), it will immediately prompt the operator to make adjustments. The PICC tip localization technology combining electromagnetic navigation and intracavitary electrocardiogram can timely correct ectopic placement during catheterization, thereby enabling timely detection of vascular malformations and prevention of ectopic placement ^[7,8].

In the PLSVC diagnostic criteria, contrast-enhanced CT serves as the basis for confirmation, while IC-ECG technology and contrast-enhanced ultrasound play key auxiliary roles through real-time localization and blood flow visualization, respectively. Additionally, electromagnetic navigation combined with intracavitary electrocardiogram can real-time judge the path of the catheter tip. Together, these technologies optimize diagnostic efficiency and clinical outcomes.

3.2. Refined post-catheterization care and risk management

3.2.1. Personalized health education

After successful PICC insertion, in addition to routine PICC care education, it is necessary to use anatomical diagrams to explain the special vascular structure of Persistent Left Superior Vena Cava (PLSVC) to patients and their families in detail, so that they understand why strict monitoring of the exposed length of the catheter is required and why special symptoms such as palpitations need to be vigilant. Instruct patients to seek medical attention immediately if they experience chest tightness, palpitations, or limb swelling. Inform them that this information is crucial for any future treatment requiring central venous access or cardiac intervention.

3.2.2. Catheter fixation and displacement monitoring

Due to the vertical course of PICC in PLSVC and the tip being close to the cardiac activity area, changes in patient position, coughing, respiratory movements, etc., may cause the catheter tip to shift inward and slip into the coronary sinus again. Therefore, the StatLock catheter securement device must be used for firm fixation. The exposed length of the catheter should be accurately measured and recorded daily, and the StatLock should be replaced weekly. Any changes need to be vigilant.

3.2.3. Complication monitoring

Focus on monitoring cardiovascular symptoms related to coronary sinus stimulation. During chemotherapy infusion, use ECG monitoring to closely observe whether the patient has palpitations, chest tightness, and changes in heart rate and rhythm. Although no arrhythmia was found in this patient during the subsequent 332 days of use, the risk always exists, and monitoring cannot be ignored.

3.2.4. Establishment of a specialized disease information file system

This measure is very important. The file content includes: patient identification information, PICC diagnosis (with CT report and images), PICC-inserted upper limb, catheter model, final insertion depth and body surface scale, final tip CT positioning, ultrasound image report, bilateral arm circumference, cardiovascular disease history, family history, etc. In addition, a prominent warning label of “Persistent Left Superior Vena Cava” should be set in the electronic medical record system to remind all subsequent medical staff.

3.2.5. Establishment of follow-up plan

(1) Conduct timely follow-up after catheterization

With the first follow-up within 24 hours to assess catheter function and the exposed scale of the puncture site.

(2) Routine follow-up

Once a month if there is no abnormality; studies have pointed out that the risk of thrombosis increases after PICC catheterization, so the follow-up frequency should be increased to once a week when the patient is in an anticoagulant or hypercoagulable state (D-dimer > 500 µg/L), and intervention should be carried out at any time if problems are found ^[9].

(3) Follow-up content

Catheter length, exposed scale, presence of redness, swelling, itching or pain at the puncture site, presence of swelling in the catheter-inserted limb, catheter patency test, arm circumference measurement, complication screening (recheck ultrasound every 3 months to rule out thrombosis), and patient complaints.

4. Discussion and conclusion

4.1. Identification is the key

When placing a catheter in the left upper extremity, any abnormal “soft resistance” or “elastic feel” should be regarded as a potential sign of vascular variations such as persistent left superior vena cava (PLSVC), and forceful catheter advancement must be avoided.

4.2. Accurate localization is required

Once PLSVC is suspected, X-ray screening must be performed initially, and enhanced computed tomography (CT) or contrast-enhanced cardiac ultrasound is preferred for confirmation and precise localization. Chest X-ray alone may not accurately distinguish whether the catheter tip is in the lower segment of the PLSVC or has entered the coronary sinus.

4.3. Necessity of multidisciplinary consultation

The 2024 guidelines of the Infusion Nurses Society (INS) recommend that the tip of a peripherally inserted central catheter (PICC) should be located in the lower 1/3 of the superior vena cava (SVC) or near the cavoatrial junction (CAJ). However, the optimal position of the PICC tip for patients with PLSVC (a vascular variation) has not been clearly defined. Some studies suggest that the optimal position for the PICC tip in PLSVC patients is at the level of the lower edge of the 5th thoracic vertebra, rather than the traditional CAJ ^[10]. Conventional

body surface measurement methods are ineffective in this context. When an abnormal position of the PICC tip is encountered, timely multidisciplinary consultation can help determine the vascular course and lumen size through imaging diagnosis, enabling individualized adjustments under the premise of ensuring safety. Studies have found that echocardiography (especially transthoracic echocardiography) is a very effective and non-invasive method to confirm the catheter's position in the coronary sinus ^[4]. When doubts exist, the risk of complications is high, or the most precise information is needed, CT angiography is the most reliable diagnostic tool. Magnetic navigation combined with intracardiac electrocardiography (ECG) can real-time observe the direction of the catheter tip, but there is currently a lack of reported data on PICC placement in patients with PLSVC.

4.4. Upgrade of nursing management

PICC nursing for PLSVC patients is an “upgraded” version, requiring stricter displacement monitoring, more targeted complication observation, and more in-depth health education.

4.5. Knowledge sharing is essential

Establishing disease-specific records and setting up warning signs to translate the experience from individual cases into important institutional measures to ensure patients' long-term medical safety.

4.6. Pre-insertion assessment

In addition to routine clinical assessment content, the assessment of cardiovascular disease history and family history should be added, including inquiries about whether the patient has congenital heart disease or a family history of vascular malformations (e.g., double superior vena cava).

Through standardized nursing and evidence-based analysis of this rare case, we not only successfully ensured the patient's safe infusion for 332 days and avoided complications caused by the catheter entering the coronary sinus but also accumulated valuable experience for our department and other medical institutions in handling similar situations. This reflects the professional value of clinical nurse specialists in addressing complex vascular access issues.

5. Conclusion

In conclusion, positioning the PICC tip in the mid-lower PLSVC (at T5–T7) is recommended as a new standard to prevent complications. Ensuring safe infusion relies on the integration of multi-modal imaging and evidence-based nursing management.

Disclosure statement

The authors declare no conflict of interest.

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Sequential Treatment and Systematic Management of Vertical Root Fracture in Molars

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Abstract: Vertical root fracture (VRF) in molars is a complex and frequently encountered dental condition. Successful management relies on accurate diagnosis, sequential treatment strategies, and systematic care. This paper provides a comprehensive review of the sequential therapeutic approaches and systematic management models for molar VRF over the past five years. Particular attention is given to the diagnostic value of cone-beam computed tomography (CBCT), recent advances in tooth-preserving techniques, and the establishment of full-course management frameworks. By constructing an integrated pathway encompassing diagnostic assessment, treatment decision-making, clinical intervention, and long-term maintenance, a “dentist–nurse–patient community” model is proposed to promote standardized clinical guidance. This collaborative model aims to extend the lifespan of affected teeth and restore optimal masticatory function.

Keywords: Vertical root fracture; Sequential treatment; Systematic management; Molar; Conservative therapy; Endodontic surgery; Regenerative restoration; Clinical protocol

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1. Introduction

Vertical root fracture (VRF) of molars refers to a longitudinal crack that extends along the root and communicates between the pulp chamber and the periodontal ligament space. It is a complex dental condition that predominantly affects middle-aged and elderly patients. According to the etiology, VRF can be categorized into primary root fractures (occurring in teeth without prior endodontic treatment) and secondary root fractures (occurring after root canal therapy)^[1].

In recent years, the widespread use of large-tapered endodontic instruments has led to a noticeable increase in the incidence of secondary VRF as a complication following endodontic treatment^[2]. However, the clinical manifestations of VRF often resemble those of pulpitis, periapical periodontitis, and periodontal disease, which contributes to frequent misdiagnosis or delayed diagnosis in clinical practice.

Traditional clinical management has largely focused on the selection of surgical or restorative techniques, often overlooking the importance of systematic management in achieving long-term functional recovery. Given these limitations, the present study aims to establish a comprehensive framework for sequential treatment and systematic management of molar VRF. By integrating diagnostic assessment, therapeutic decision-making, and ongoing clinical follow-up, this framework is intended to provide standardized clinical guidance that supports both tooth preservation and functional rehabilitation, thereby improving clinical outcomes and patient satisfaction.

2. Disease assessment and diagnostic management

Accurate diagnosis is the cornerstone of effective management for vertical root fracture (VRF). Due to the subtle and variable clinical manifestations of VRF, its diagnosis requires comprehensive consideration of clinical symptoms, radiographic findings, and intraoperative observations.

2.1. Clinical evaluation

Clinically, patients often present with localized discomfort during mastication, sensitivity to percussion, or occasional swelling of the gingiva. In molars, VRF frequently results in narrow and deep periodontal pockets along the fracture line, accompanied by localized alveolar bone resorption. Probing in these areas frequently reveals a characteristic “sharp and narrow” periodontal defect. However, these signs can overlap with those of endodontic or combined periodontic–endodontic lesions, making a definitive diagnosis challenging.

2.2. Radiographic examination

Periapical radiographs remain a fundamental diagnostic tool, yet they often fail to reveal early or minor fractures due to projection limitations. In contrast, cone-beam computed tomography (CBCT) has emerged as a critical adjunct in detecting subtle root fractures and assessing surrounding bone morphology in three dimensions. CBCT can visualize discontinuity of root dentin, localized bone defects, and root separation, thereby improve the diagnostic accuracy and reducing the risk of misdiagnosis^[3].

2.3. Diagnostic decision-making

A stepwise diagnostic approach is recommended, beginning with symptom assessment, followed by periodontal probing, radiographic evaluation, and, if needed, operative confirmation under magnification. The use of dye staining, transillumination, and endoscopic-assisted visualization further enhances detection sensitivity. When a fracture is confirmed, clinicians should promptly categorize it according to location (coronal, middle, or apical third) and extent (partial or complete) to guide appropriate treatment planning.

2.4. Diagnostic challenges and clinical implications

Despite the advancement of imaging technologies, diagnosing VRF at an early stage remains difficult. Subclinical fractures may be obscured by restorative materials or masked by secondary infection and bone loss. Therefore, the integration of multimodal diagnostic data, coupled with consistent follow-up assessments, is essential for achieving reliable and reproducible diagnostic outcomes. Ultimately, a standardized diagnostic protocol facilitates timely intervention, enhances tooth preservation potential, and forms the foundation for subsequent therapeutic decisions.

3. Sequential treatment strategies and clinical management

3.1. Comprehensive evaluation and treatment planning

Effective management of vertical root fracture (VRF) in molars requires a sequential and integrated approach that aims to preserve tooth vitality and maintain long-term function. Once a definitive diagnosis is established, a detailed assessment of the fracture pattern, periodontal support, occlusal stress distribution, and the patient's systemic health should be conducted. These factors critically influence therapeutic decision-making and the design of an individualized treatment plan. In cases where the fracture remains localized and the tooth retains structural stability, conservative and minimally invasive techniques are prioritized to preserve as much natural tooth tissue as possible.

3.2. Conservative and minimally invasive approaches

For partial or early fractures, conservative management can effectively restore root function and extend tooth longevity. Adhesive systems combined with fiber post reinforcement or bioceramic sealers can re-establish root integrity and enhance resistance to further stress. Additionally, careful adjustment of the occlusal scheme helps reduce masticatory overload on the affected tooth. Clinical studies have shown that combining minimally invasive repair with controlled occlusion markedly improves prognosis and patient comfort, while reducing the probability of subsequent fracture propagation.

3.3. Surgical and regenerative management

When fractures are extensive or involve the bifurcation and apical regions, surgical intervention becomes a necessary component of the treatment sequence. Procedures such as root amputation, hemisection, and intentional replantation may be employed to eliminate the fractured segment while maintaining partial tooth function. Microsurgical magnification and the use of fine instruments reduce operative trauma, ensuring more precise manipulation of the root and surrounding tissues. The incorporation of bone grafting materials and guided tissue regeneration (GTR) membranes during surgery enhances periodontal healing, promotes new bone formation, and contributes to long-term functional recovery ^[4].

3.4. Restorative rehabilitation and occlusal optimization

Postoperative prosthetic restoration plays a vital role in reestablishing occlusal stability and preventing recurrent fractures. Full-coverage crowns, onlays, and endocrowns distribute masticatory forces evenly across the tooth structure, thereby lowering stress concentration at the fracture site. In complex cases with weakened supporting structures, the use of occlusal splints, careful bite adjustment, and regular evaluation are essential ^[5]. These restorative measures ensure the harmonious integration of the treated tooth within the masticatory system and contribute to sustainable long-term outcomes.

3.5. Sequential and systematic management integration

Sequential management integrates the entire therapeutic process into a dynamic continuum encompassing diagnosis, treatment, restoration, and maintenance. Each stage is closely linked to the next, forming a standardized and reproducible clinical pathway. Regular clinical and radiographic reviews facilitate the early identification of complications such as reinfection, marginal leakage, or secondary fracture, enabling timely intervention. More importantly, a systematic management model, anchored in multidisciplinary collaboration between clinicians,

dental technicians, and patients, ensures consistent treatment quality, enhances clinical predictability, and maximizes tooth survival outcomes.

4. Construction of a systematic management model and case-based application

4.1. Concept and framework of systematic management

The systematic management model for vertical root fracture (VRF) integrates diagnostic precision, evidence-based treatment selection, and long-term follow-up into a unified clinical pathway. Rather than treating each stage as an independent therapeutic step, this model conceptualizes patient care as a continuous, interactive process that adapts dynamically to clinical feedback and healing outcomes. The framework emphasizes early detection, sequential decision-making, interdisciplinary collaboration, and patient-centered care, all essential elements for optimizing prognosis. Through structured integration, the model standardizes clinical procedures, reduces variability among practitioners, and enhances the predictability of treatment outcomes ^[6].

4.2. Core components of the management system

The model consists of four interrelated modules: diagnostic standardization, treatment protocol optimization, restorative-functional integration, and long-term monitoring. The diagnostic standardization module promotes consistent use of multimodal imaging and clinical examination criteria to ensure accurate identification of fracture characteristics. The treatment protocol optimization module focuses on establishing clear clinical decision thresholds between conservative and surgical approaches, improving efficiency and reducing overtreatment. The restorative-functional integration module links the surgical or conservative treatment outcome directly with restorative design, emphasizing occlusal harmony and biomechanical stability. Finally, the long-term monitoring module introduces structured follow-up intervals and digital data tracking to evaluate periodontal health, bone remodeling, and function restoration over time. Collectively, these modules form a closed-loop system that supports dynamic feedback, allowing clinicians to modify strategies according to healing progress and patient-specific risk factors.

4.3. Application in clinical case analysis

Clinical application of the systematic management framework demonstrates its practicality and flexibility. For instance, in a representative case of mandibular molar VRF, the standardized diagnostic process, comprising CBCT imaging, periodontal probing, and transillumination, enabled clear delineation of the fracture plane. Based on the assessment, a minimally invasive surgical approach was chosen, followed by intentional replantation and microsurgical reattachment of the fractured segment. The use of bone grafting combined with bioceramic sealing facilitated periodontal regeneration, while subsequent full-coverage restoration ensured functional stabilization.

During the follow-up period, the systematic management protocol guided routine imaging assessments and occlusal adjustment, ultimately resulting in stable bone healing and continued tooth function over a 24-month observation period. Compared to conventional intervention methods, the stepwise integrated strategy reduced postoperative complications, improved survival rate, and significantly enhanced patient satisfaction ^[7].

4.4. Clinical significance and prospective value

The establishment of a systematic management model represents a paradigm shift in the clinical handling of VRF.

It redefines treatment from being procedure-centered to outcome-oriented, emphasizing long-term functional preservation rather than short-term repair. By structuring clinical steps within a repeatable framework, this model provides both a theoretical foundation and a practical guideline for clinicians. Moreover, its adaptability to emerging biomaterials, digital imaging, and regenerative technologies ensures its continued relevance in modern endodontic practice. Future research should aim to validate this model through multicenter clinical trials and quantitative outcome measurement, further refining its application scope and standardization potential.

5. Discussion

The findings and clinical experiences summarized in this study underscore that vertical root fracture (VRF) is not merely a mechanical injury but a multifactorial pathology influenced by occlusal stress distribution, endodontic integrity, restorative design, and periodontal support. The sequential and systematic management model proposed herein redefines the therapeutic pathway by integrating early diagnosis, evidence-based intervention, and structured maintenance. Such an approach facilitates a transition from traditionally reactive management to proactive, predictive care. By emphasizing diagnostic accuracy and multidisciplinary coordination, clinicians can significantly reduce misdiagnosis rates and improve treatment predictability.

From a theoretical perspective, this framework extends the understanding of VRF beyond a static lesion model to a dynamic, biologically responsive system. Healing outcomes depend not only on the fracture morphology but also on microenvironmental factors such as inflammation control, bone remodeling capacity, and vascular supply. The integration of regenerative and biomimetic principles in treatment further expands the potential for functional rehabilitation while minimizing invasive procedures.

Clinical implementation of the systematic management protocol has demonstrated substantial advantages in ensuring biological healing and maintaining occlusal stability. The emphasis on treatment sequencing, ranging from initial assessment to restorative rehabilitation, enables personalized strategies tailored to the extent and progression of each fracture. These strategies improve tooth survival rates, reduce postoperative complications, and enhance patient satisfaction through careful follow-up and functional evaluation.

Moreover, standardized documentation and digital imaging analytics embedded in the management system provide valuable data for longitudinal evaluation and interdisciplinary communication. Such structured data collection aids in refining diagnostic criteria, predicting prognosis, and facilitating evidence accumulation for future guideline development ^[8].

Despite the promising advantages, several challenges remain. Precise early detection of microfractures continues to depend on high-resolution imaging and clinician expertise. Variations in operator skill, case complexity, and patient compliance may influence long-term outcomes. Furthermore, large-scale multicenter studies are needed to validate the reproducibility of the sequential management model and its applicability across diverse clinical settings. Future research should also explore the integration of artificial intelligence–assisted diagnostic algorithms and biomaterial-based regenerative approaches, which could further enhance the sensitivity, precision, and biological compatibility of fracture management.

6. Conclusion

In conclusion, the proposed sequential and systematic management model offers a comprehensive and structured

framework for addressing vertical root fractures in molars. By unifying diagnostic, therapeutic, and restorative elements into a cohesive sequence, it standardizes clinical decision-making and improves outcome predictability. This model not only elevates the scientific understanding of VRF but also provides a practical and sustainable pathway for clinical application. As technology and biomaterials evolve, the integration of digital, regenerative, and data-driven strategies will continue to refine this model, contributing to more precise, conservative, and patient-centered management of complex endodontic fractures.

Disclosure statement

The authors declare no conflict of interest.

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Current Situation Analysis and Prospect of Precocious Puberty in Children at Home and Abroad Based on the Combination of Traditional Chinese and Western Medicine

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Abstract: *Objective:* To review the scientific research results of early puberty in children in the past decade, and to explore the current status, hot spots and frontiers of research in the field of early puberty in children. *Methods:* From January 1, 2014 to April 30, 2024, literature on early puberty in children was retrieved from CNKI database and Web of Science (WOS) core collection. CiteSpace6.3. R1 software was used for bibliometric analysis of authors, institutions and key words, and related visual maps were drawn. *Results:* A total of 1548 English literatures and 1113 Chinese literatures were included. The number of published papers in both Chinese and English showed an increasing trend. The authors of the high production in Chinese were Ye Jin and Yang Li, and the high production institutions were the pediatrics department of Hubei University of Chinese Medicine and Shuguang Hospital Affiliated to Shanghai University of Chinese Medicine. The authors are Latronico, Ana Claudia, and Universidade de Sao Paulo. Hot topics in Chinese and English studies include bone age, hormones, genetic inheritance, the correlation between precocious puberty and obesity and short stature. *Conclusion:* There is an increasing trend of research in the field of early puberty in children. The research on physical identification of children with precocious puberty and the dynamic detection of precocious puberty, height and obesity by Internet is worthy of continuous attention by domestic scholars.

Keywords: Precocious puberty; CiteSpace; Bone age; Growth and development; Sex hormones; Constitution of traditional Chinese medicine

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1. Introduction

Precocious puberty (PP) is a pediatric endocrine condition characterized by the onset of menstruation before the age of ten years in girls and the development of secondary sexual features before the age of 7.5 years in boys^[1]. According

to clinical epidemiological research, the incidence of premature puberty is rising year, and the developmental stage of children's puberty is progressively progressing globally ^[2]. In China, precocious puberty is also growing more common in youngsters, ranking as the second most common pediatric endocrine illness. Typically, females are more likely to have this condition than boys ^[3]. Children's sexual health services must be strengthened in accordance with the State Council's Program for the Development of Chinese Children ^[4]. Despite advancements in research, there remain issues and difficulties because of the intricacy of influencing components and variations in study methodologies. Thus, it is crucial to thoroughly examine the patterns and hotspots of early puberty in children both domestically and internationally.

2. Data and methods

2.1. Data sources and search methods

The SCI, SSCI, and WOS core databases provided the English data used in this investigation. This study obtained the full record of the retrieved data with the cited references, exported it in plain text format as the source of the data, and retrieved a total of 1548 documents. The search formula for the subject term search is as follows: (((((TS = (Precocious Puberties)) OR TS = (Precocious Puberty)) OR TS = (Central Precocious Puberties)) OR TS = (Central Precocious Puberty)) AND DT = (Article)) AND LA = (English)) AND DOP = (2014-01-01/2024-04-30). A total of 1,578 academic papers were retrieved from the literature during the search period of January 1, 2014, to April 30, 2024. The Chinese data were obtained from the CNKI Journal Full Text Database, subject term search. The search formula used was: SU = (precocious puberty + precocious girls + central precocious puberty + idiopathic precocious puberty). Before the literature was exported, conferences and articles unrelated to childhood precocious puberty were manually excluded. In the end, 1117 documents were obtained and exported in Refworks citation format, serving as the data source. CiteSpace de-weighting was used to analyze the 1113 documents.

2.2. Data handling

The downloaded plain text file for this study is titled Download_*, and CiteSpace is used to locate, extract, and examine it.

2.3. Statistical methods

A literature visualization and analysis program called CiteSpace 6.3.R1 was utilized in this work to search for terms in the data. The trend of yearly publications in the literature was plotted using Excel.

3. Research status

3.1. Analysis of the amount of publications

There is a generally fluctuating, rising trend in the number of published studies on PP, both domestically and globally. China, in comparison with other countries, has a very small body of literature on the management of child health, but it is expanding. Due to the literature collection as of April 30, 2024, there is a decreasing trend in the number of publications in 2024. In 2022, there were 197 publications in the English-language literature, while in 2023, there were 155 publications in China. Trends in the number of articles issued are shown in **Figure 1**.

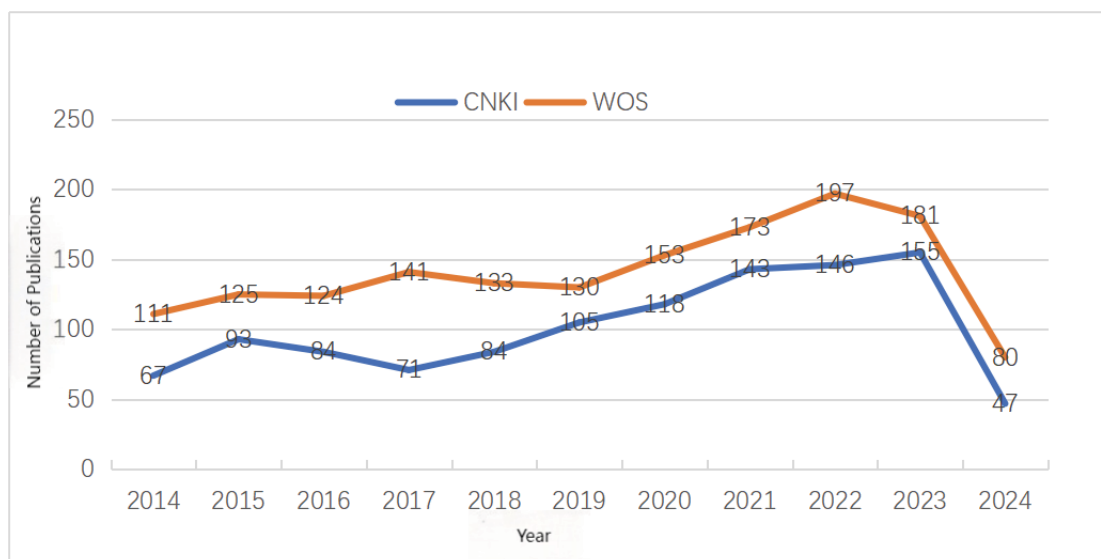


Figure 1. Number of domestic and international publications each year in the subject of child premature puberty.

3.2. Institution and author collaboration network

The data in **Table 1** and **Figure 2** demonstrates that the top 10 domestic organizations in terms of publications published 51 documents total, which accounts for 4.58% of the Chinese literature, while the top 10 foreign organizations in terms of publications published 370 documents total, accounting for 23.90% of the English literature. Ye Jin and Yang Li, who have the most publications, have each published eight articles. A core author group has not yet been formed, and the number of core authors who obtained three or more publications was 35 out of 162 total publications, or 27%. This suggests that the percentage of authors with higher publication volume is small and that there is not a strong bond between authors. This implies that there is a low percentage of authors with a high volume of publications, that there is not a strong bond among authors, and that there is no core group of authors. Of them, Yang Li's team at Jiangxi Children's Hospital's Department of Laboratory Medicine has published up to 44 articles. This team is the core for research on gene polymorphisms, the early development of precocious puberty girls' breasts, and the relationship between environmental endocrine disruptors and the clinical and regression of precocious puberty in children ^[5,6]. In the English literature, Ana Claudia Latronico has published the most, with 19 works. The group's primary focus is on Latronico, while Ana Claudia primarily studies the genetic mechanisms of genes and regulatory factors in children who experience early puberty ^[7,8]. There is a total of 28 core authors with ≥ 5 articles, accounting for 231 articles, or 28.1% of all articles. 28.1% of all articles, suggesting even more concentration on the part of English literary writers.

Table 1. Volume of publications by major domestic and international organizations

Number	Chinese		English	
	Organization Name	Number of posts	Organization Name	Number of posts
1	Hubei University of Chinese Medicine	8	Universidade de Sao Paulo	46
2	Department of Pediatrics, Shanghai University of Traditional Chinese Medicine Affiliated Shuguang Hospital	8	Harvard University	44
3	Heilongjiang University of Chinese Medicine	5	Universidade Estadual Paulista	41
4	Department of Laboratory Medicine Jiangxi Children's Hospital	5	Universite Paris Cite	40
5	Department of Pediatrics, Ruijin Hospital Affiliated to Shanghai Jiao Tong University School of Medicine	5	University of California System	38
6	The Children's Hospital of Fudan University	4	Assistance Publique Hopitaux Paris (APHP)	37
7	Shanghai Municipal Hospital of Traditional Chinese Medicine Affiliated to Shanghai University of Traditional Chinese Medicine	4	Shanghai Jiao Tong University	36
8	Department of Pediatrics, Yueyang Hospital of Integrated Traditional Chinese and Western Medicine, Affiliated to Shanghai University of Traditional Chinese Medicine	4	Institut National de la Sante et de la Recherche Medicale (Inserm)	36
9	Nanjing University of Chinese Medicine Affiliated Hospital	4	Harvard Medical School	32
10	Department of Pediatrics, Affiliated Hospital of Nanjing University of Chinese Medicine	4	Huazhong University of Science & Technology	20



Figure 2. Graph of collaborative relationships between domestic and foreign authors.

The number of institutional publications can be used to determine the distribution of research power (**Figure 3**). The Universidade de São Paulo institution has the most publications out of the 270 research institutes in the English literature. Harvard University's main research group serves as the institution's focal point. The Department of Pediatrics at Shuguang Hospital, affiliated with Shanghai University of Traditional Chinese Medicine, is the main core research group in the Chinese literature. These organizations reflect a specific area of research that focuses on children's early puberty.



Figure 3. Graph of collaborative relationships between domestic and foreign institutions.

3.3. Keyword co-occurrence analysis

The higher the frequency of keyword occurrences, the more relevant they are in this research field in **Figure 4**. The top fifteen keywords (**Table 2**) in Chinese were precocious puberty, girls, children, sex hormones, puberty, precocious puberty, treprostini, growth and development, vitamin D, risk factors, growth hormone, diagnosis, ovary, bone age, and leuprolide. The frequency threshold of keywords in the foreign literature were PP, central precocious puberty (CPP), children, girls, age, diagnosis, and treatment were among the top 15 keywords (**Table 2**), along with growth, final height, expression, menarche, mutations, body mass index, adult height, luteinizing hormone (LH), and sexual precocity.

One method to gauge an element's significance is by contemplating its centrality. An element is deemed highly important if its centrality is above 0.1. Keywords with a high frequency of occurrence do not always translate into high centrality in the keyword co-occurrence network, according to the investigation.



Figure 4. Keywords co-occurrence map of English and Chinese publications.

Table 2. Keywords, centrality, and frequency statistics on children's early puberty

Number	Chinese			English		
	Frequency	Centrality	Keyword	Frequency	Centrality	Keyword
1	313	0.56	precocious puberty	488	0.04	precocious puberty
2	231	0.36	girls	319	0	central precocious puberty
3	151	0.51	children	294	0.12	children
4	103	0.19	sex hormone	210	0.01	girls
5	58	0.04	adolescence	180	0.01	age
6	41	0.37	precocious	155	0.03	diagnosis
7	36	0.06	Triptorelin	149	0.03	growth
8	31	0.34	growth and development	96	0.28	final height
9	31	0.02	vitamin D	91	0.06	expression
10	30	0.14	risk factors	86	0.08	menarche
11	30	0.1	growth hormone	78	0.06	mutations
12	28	0.09	diagnose	75	0.11	body mass index
13	27	0.03	ovary	69	0.06	adult height
14	26	0.24	bone age	69	0.19	luteinizing hormone
15	26	0.11	Leuprorelin	65	0.05	sexual precocity

3.4. Keyword clustering analysis

By using cluster analysis, we can learn about the characteristics of research on precocious puberty in children at different times (**Figure 5**). In the Chinese literature, eleven clustering areas are displayed, and the associated clustering results can be broadly divided into three categories: clinical research, symptomatic research, and mechanism research. The clustering identity document (ID) numbers #1, #3, #6, and #8 primarily concentrate on “clinical research,” while #5 represents multidisciplinary collaboration in the use of TCM to treat children. The youngsters can be treated with TCM using a multidisciplinary approach. In the foreign language literature, of the 11 clustering areas, #0, #1, #2, and #9 primarily represent “clinical research,” #3 and #4 represent common symptoms, which are also pressing problems that need to be resolved, and #6, #7, #8, and #10 examine the disease’s occurrence and treatment mechanism from the standpoint of biohormones and other factors.

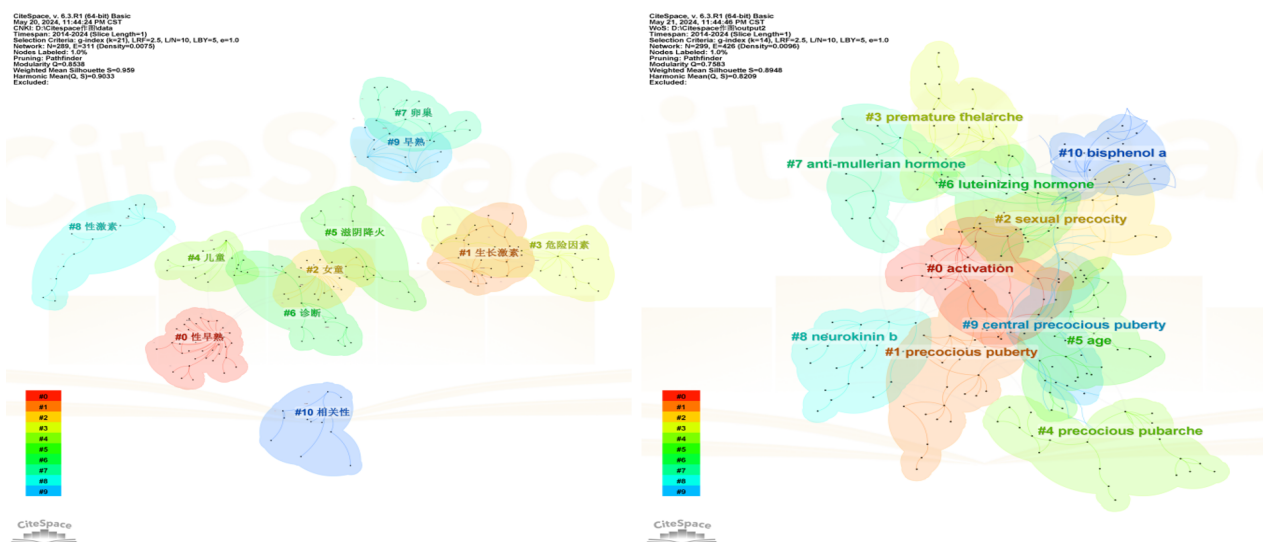


Figure 5. Keywords clustering map of English and Chinese publications.

3.5. Keyword emergence analysis

There were 25 emerging terms in each of the years 2014–2024 based on an analysis of keyword emergence in the field of premature puberty research conducted both domestically and internationally (**Figure 6**). The terms “sex hormone” (5.85) and “vitamin D” (3.74), respectively, emerged with the greatest intensity in the Chinese literature. Hot terms like “depression” and “nourishing yin and reducing fire” emerged in this field of study at this time. The terms “bone age” (5.58), “overweight” (3.74), “bone marrow” (5.85), and “overweight” (5.85) were the most often occurring terms in the foreign language literature. “Too heavy” (4.73). Popular terms like “genome-wide association,” “short stature,” and “insulin resistance” emerged in this field of study during this time.

Top 25 Keywords with the Strongest Citation Bursts

Keywords	Year	Strength	Begin	End	2014 - 2024
treatment	2014	3.1	2014	2016	
infant	2014	2.27	2014	2015	
depression	2014	1.82	2014	2018	
diagnose	2014	3.22	2015	2017	
etiology	2015	2.72	2015	2016	
efficacy	2015	2.16	2015	2017	
differential diagnosis	2015	1.88	2015	2016	
Da-Bu-Yin-Wan	2015	1.98	2016	2018	
uterine volume	2016	1.96	2016	2017	
vitamin D	2017	3.74	2019	2020	
review	2019	3	2019	2020	
treatment outcomes	2019	2.11	2019	2021	
triptorelin	2014	1.55	2019	2021	
leptin	2020	2.02	2020	2021	
lipid metabolism	2020	1.74	2020	2021	
ultrasound	2014	1.82	2021	2022	
Zi Yin Jiang Huo	2021	1.64	2021	2022	
adiponectin	2021	1.64	2021	2022	
sex hormone	2014	5.85	2022	2024	
bone age index	2018	2.73	2022	2024	
diagnostic value	2022	2.58	2022	2024	
pelvic ultrasound	2018	2.3	2022	2024	
bone age	2014	1.95	2022	2024	
follicular size	2022	1.62	2022	2024	
adverse effects	2015	1.56	2022	2024	

Top 25 Keywords with the Strongest Citation Bursts

Keywords	Year	Strength	Begin	End	2014 - 2024
secretion	2014	4.47	2014	2015	
breast cancer	2014	4.03	2014	2015	
follicle stimulating hormone	2014	3.85	2014	2016	
body composition	2014	3.66	2014	2015	
adolescent girls	2014	3.25	2014	2015	
features	2014	3.25	2014	2015	
assays	2015	3.88	2015	2017	
missense mutation	2016	4.64	2016	2017	
gene	2014	3.75	2016	2017	
premature adrenarche	2016	3.61	2016	2017	
insulin resistance	2016	3.57	2016	2017	
genome wide association	2016	3.48	2016	2019	
imprinted gene mkkn3	2017	4.14	2017	2018	
adolescents	2014	3.69	2017	2018	
cyp17a1	2017	3.62	2017	2018	
in utero	2018	3.39	2018	2020	
mechanisms	2018	3.26	2018	2021	
bone mineral density	2015	4.5	2019	2020	
quality of life	2019	3.26	2019	2021	
short stature	2014	4.34	2020	2021	
estradiol	2016	3.65	2020	2021	
genetics	2020	3.46	2020	2021	
bone age	2021	5.58	2021	2022	
overweight	2021	4.73	2021	2024	
secular trends	2015	3.41	2022	2024	

Figure 6. Visualization graph of emergent words.

4. Discussion

4.1. Analysis of annual publication volume and author organization distribution

Based to the trend of annual publication growth, pertinent studies in the area of children's premature puberty is still intensifying, indicating that this area will continue to be a research hotspot in the years to come. Even though there exist a number of more visible author cooperation groups in this field, they are largely independent of one another and do not communicate or cooperate well enough, which suggests that research teams should improve their communication and cooperation in order to jointly advance the in-depth study of children's untimely puberty. Simultaneously, we can observe the disparity between the quantity of literature published domestically and internationally, with comparatively few high-yield creators and institutions and a little deficiency of domestic literature compared to foreign countries.

4.2. Keyword co-occurrence and cluster analysis

The clinical management of premature puberty and biological mechanism study are the primary areas of attention for research hotspots in China related to precocious puberty in children. The primary focus of clinical research is on risk factors, TCM evidence-based treatment, the efficacy and safety of medication therapy, and the foundation of diagnosis in both Chinese and Western medicine^[9-11]. Gene regulation (such as the imprinted gene MKRN3), the neuroendocrine axis, the hypothalamic-pituitary-gonadal axis (HPGA) and the regulation of reproductive system development through the feedback of endocrine hormones like Kisspeptin neurokinin B, leptin,

testosterone, and other endocrine hormones are the main areas of focus for biological mechanism research ^[12–14]. In addition to studying related clinical symptomatic manifestations (e.g., precocious breasts, precocious pubic hair, menarche, etc.), diagnostic and therapeutic approaches (e.g., activation, agonist therapy, etc.), gene mutations, and genetic mechanisms of regulatory factors, foreign studies have become more varied, paying more attention to the body mass index and final height of children with precocious puberty.

4.3. Keyword emergence analysis

Research on early puberty in children has focused on bone age, pelvic ultrasonography, psychological state, and correlation with short height and overweight, according to an analysis of emerging phrases. Girls' uterine development is evaluated by pelvic ultrasonography, which is useful for clinical diagnosis. Research on early puberty in children has focused on bone age, pelvic ultrasonography, psychological state, and correlation with short height and overweight, according to an analysis of emerging phrases. Girls' uterine development is evaluated by pelvic ultrasonography, which is useful for clinical diagnosis ^[15]. According to an analysis, GnRHa, including treprostinil, leuprolide, and other medications, are the most commonly used by domestic researchers to treat PP. Some studies have found a correlation between vitamin D levels and the effects of GnRHa treatment ^[16]. Yet the exact mechanism by which vitamin D deficiency causes premature puberty in children is still unclear, and more research is required. Studies conducted abroad have focused more on how body composition, neurokinin B, LH, anti-Müllerian hormone (AMH), and bisphenol A affect the regulation of precocious puberty. A multifaceted viewpoint for the in-depth investigation of the pathophysiology of premature puberty is offered by the interaction mechanism of these regulators and their connection to PP.

5. Research hot spots and prospects

5.1. CPP

Pathogenesis of CPP: the precise processes underlying the early onset of HPGA function have been the subject of research, particularly the pulsatile secretion of GnRH and its regulatory mechanisms. Studies on the safety, effectiveness, and long-term follow-up outcomes of GnRHa therapy have gradually increased in recent years ^[10,17,18]. In order to improve therapy outcomes, researchers are investigating the best time and dose for GnRHa medication. The predictive value of the diagnosis of CPP in girls is improved when pelvic ultrasonography and bone age are combined. Other findings include the following: urine GnRH and urine LH testing may be an alternative to traditional serum LH testing; morning urine LH has a better predictive significance for the diagnosis of CPP; urine sampling is also more acceptable than continuous blood sampling; and so on ^[27]. However, there aren't enough high-caliber, multicenter, large-sample studies to confirm its accuracy and dependability. Future clinical research can further enhance and improve these noninvasive diagnostic methods.

5.2. TCM treatment

PP belongs to the category of “breast lump”, “pre-menstrual period” and “early sprouting of heavenly decadence” in Chinese medicine. Children are the body of young yin and young yang, which makes it easy for the balance of yin and yang to be out of balance, and the deficiency of the kidney and the liver to be exuberant, leading to “early sprouting of the deca”. In Chinese medicine, the diagnosis is mostly based on the Zang-fu organs, mainly involving the kidney, liver, and spleen ^[9]. The internal and external treatments of Chinese medicine can

significantly slow down the growth of children's bones and increase the expected height. Internal treatment mainly includes nourishing yin and supplementing the kidney (Zhi Bai Di Huang Pill, Da Tonic Yin Wan, etc.), detoxifying the liver and relieving depression (Chai Hu Shugan Powder, Danzhi Xiaoyao Pill, Longdan Xiegan Decotion as the representative formula), and resolving phlegm and dispersing knots (strengthening the spleen and dispersing dampness as the method), while external treatment includes auricular acupoints pressure and tuina method. The combination of internal and external treatments with TCM constitution treatment based on syndrome differentiation has achieved significant clinical efficacy and good safety ^[9,11].

Chinese medicine is not only gentle, non-invasive, and safe, but also focuses on the overall concept of TCM, which believes that different regions, the environment, and other factors can lead to differences in children's physique, and the different physique of an individual determines his or her susceptibility to certain diseases and tendency to certain TCM certificates ^[20,21]. As a result, patients should get therapy based on the various constitutions of the syndrome differentiation. TCM is currently making some strides in understanding the physical characteristics of children who experience early puberty. The fact that some kids still struggle to recognize and address them is still an issue, though. To provide a scientific foundation for the creation of a more individualized treatment plan, researchers can further examine the physical characteristics of children who experience early puberty in the future, particularly the identification of the Chinese medicine physique of children with Pingqi parts of the body ^[11]. TCM also focus on the guidance of living habits during the treatment process. Though there is a dearth of high-quality studies and clinical research evidence, TCM has some effectiveness in treating premature puberty. More multi-center randomized controlled studies will be carried out in the future to investigate the mechanism of action and confirm its safety and effectiveness.

5.3. Digital informatization

In the area of managing a child's sexual development, we may offer information more accurately and effectively by using the Internet or artificial intelligence (AI). For instance, using the online platform or AI assistant before the consultation to educate yourself on the child's sexual development symptoms, potential issues, and the causes and consequences of any tests or medications the doctor may prescribe later. Furthermore, it is possible to create a platform for health management that is more organized. For instance, WeChat groups are used for regular Q&A sessions; small programs are used for real-time dynamic monitoring of children's growth and development; and public figures are used to disseminate pertinent information, such as the signs of premature puberty, how it progresses, and how it affects children's height. Precocious puberty in children is influenced by a variety of circumstances, and our comprehensive, individualized health management service allows for intervention and life management to better support children's healthy development ^[22].

5.4. Adult height and obesity

The issues of height and obesity in adults are intimately linked to PP in childhood ^[23]. A child's height and bone growth are impacted by premature puberty, and girls may experience despair and low self-esteem as a result of these physical changes. Obesity and PP also interact to cause less-than-ideal height ^[24]. PP may make the obesity issue worse, and excessive adiposity in obese children raises the release of leptin from adipocytes, which may cause the HPGA to be activated too soon ^[25]. While the current treatment approaches are successful, they have significant drawbacks and adverse effects, thus future research into safer, more cost-effective, and more efficient medications or therapies is important.

5.5. Environmental factors

The findings of several domestic and international research show that environmental variables, particularly short-term exposure to air pollution, are linked to early puberty in children, particularly in females ^[26,27]. For instance, long-term exposure to BPA, significantly increases the risk of precocious puberty in children, particularly in the girl population ^[28]. The increased incidence of precocious puberty in children during the epidemic may be related to changes in children's lifestyles (e.g., decreased time spent outdoors, increased time spent on electronic screens, and changes in dietary habits), supporting the idea that the environment has an impact on precocious puberty ^[29].

5.6. Intestinal flora

Although the mechanism of the reciprocal changes in the sexually dimorphic nature of the human intestinal flora has not yet been accurately reported, sex hormone levels may be linked to the intestinal flora, which has been found to be influenced by sex hormone levels during puberty, even producing sex-specific flora ^[30]. It may also influence central nervous system components involved in the regulation of puberty ^[31]. Future research might investigate the role of gut flora in the pathophysiology of precocious puberty in order to potentially prevent and cure premature puberty, such as by the use of specialized probiotic treatment, as the precise mechanism by which gut microbiota affects HPGA is yet unclear.

5.7. Gene therapy

Early puberty has been linked to epigenetic changes and mutations in certain genes. Developmental issues have also been linked to EZH1 gene loss of function, and the synergistic effects of multiple mutated genes in the gene network can also affect the initiation of pubertal development ^[32,33]. The use of gene therapy in the treatment of premature puberty is growing more and more promising as gene monitoring technology advances. In the future, it may be used to precisely cure precocious puberty. For instance, repairing damaged genes, identifying gene targets, creating medications for gene therapy, etc.

6. Conclusion

Children who have precocious puberty have a complicated endocrine condition. Multidisciplinary collaboration, individualized comprehensive interventions, precision medicine, and the use of safe, noninvasive technologies are some of the traits of this field's research trends. Future research should examine the potential and safety of new technology in the study of precocious puberty, as well as the continuous developments in gene therapy and traditional Chinese medicine treatments.

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Disclosure statement

The authors declare no conflict of interest.

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A Case Report of Ulnar Osteotomy for the Treatment of Monteggia Fracture in a Child

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Abstract: Monteggia fracture-dislocation is a rare and complex injury that typically involves an ulnar fracture combined with a dislocation of the proximal radioulnar and radiocapitellar joints. Ulnar osteotomy is an effective treatment method. This article reports a case of chronic Monteggia fracture in an 11-year-old male patient successfully treated with a simple proximal ulnar osteotomy.

Keywords: Monteggia fracture; Ulnar osteotomy; Chronic fracture

Online publication: Dec 31, 2025

1. Introduction

Monteggia fracture-dislocation is a rare and complex injury that usually involves an ulnar fracture combined with a dislocation of the proximal radioulnar and radiocapitellar joints. These injuries account for less than 1% of pediatric forearm fractures and primarily occur in children aged 4–10 years. Due to the unique physiological anatomy of the pediatric elbow joint and the lack of awareness of this condition among non-pediatric orthopedic specialists, many children with Monteggia injuries are often misdiagnosed early on. The condition develops into a chronic Monteggia fracture and is only diagnosed after corresponding symptoms appear. On August 4, 2023, the Traditional Chinese Medicine Hospital of Chuxiong Yi Autonomous Prefecture admitted a child with a chronic Monteggia fracture. The patient was treated with a simple proximal ulnar osteotomy and plate internal fixation, achieving favorable therapeutic effects. The case is reported as follows.

2. Clinical data

An 11-year-old male patient, height 145 cm and weight 37 kg, was injured while playing football at school on July 21, 2023, at 17:00. The injury involved his left elbow, and he immediately felt pain and swelling in the left

elbow area, with limited movement. There were no symptoms of headaches, chest pain, or abdominal pain. The patient was taken to a local hospital by his family for inpatient treatment. The local doctor considered a left ulnar beak fracture and recommended manual reduction and plaster fixation for conservative treatment. One week after treatment, the patient was discharged. On August 4, 2023, the patient returned to the hospital for a follow-up x-ray, which indicated dislocation of the left radial head. The patient was then transferred to our hospital for treatment. Physical examination upon admission revealed swelling on the lateral side of the left elbow, tenderness on the anterolateral aspect of the elbow joint, and a palpable radial head protruding forward. The left elbow joint exhibited normal extension, with a flexion angle 10° smaller than the right side. Distal blood supply and sensation were intact. Auxiliary examination: The DR examination revealed a dislocation of the left radial head, while the right humeroradial joint was in good alignment. An MRI of the right elbow joint revealed injuries to the brachialis muscle, flexor digitorum profundus, and surrounding subcutaneous soft tissues of the left elbow joint, with no incarcerated objects in the proximal radioulnar joint (see **Figure 1**). Admission diagnosis: left Monteggia fracture (Bado type I).

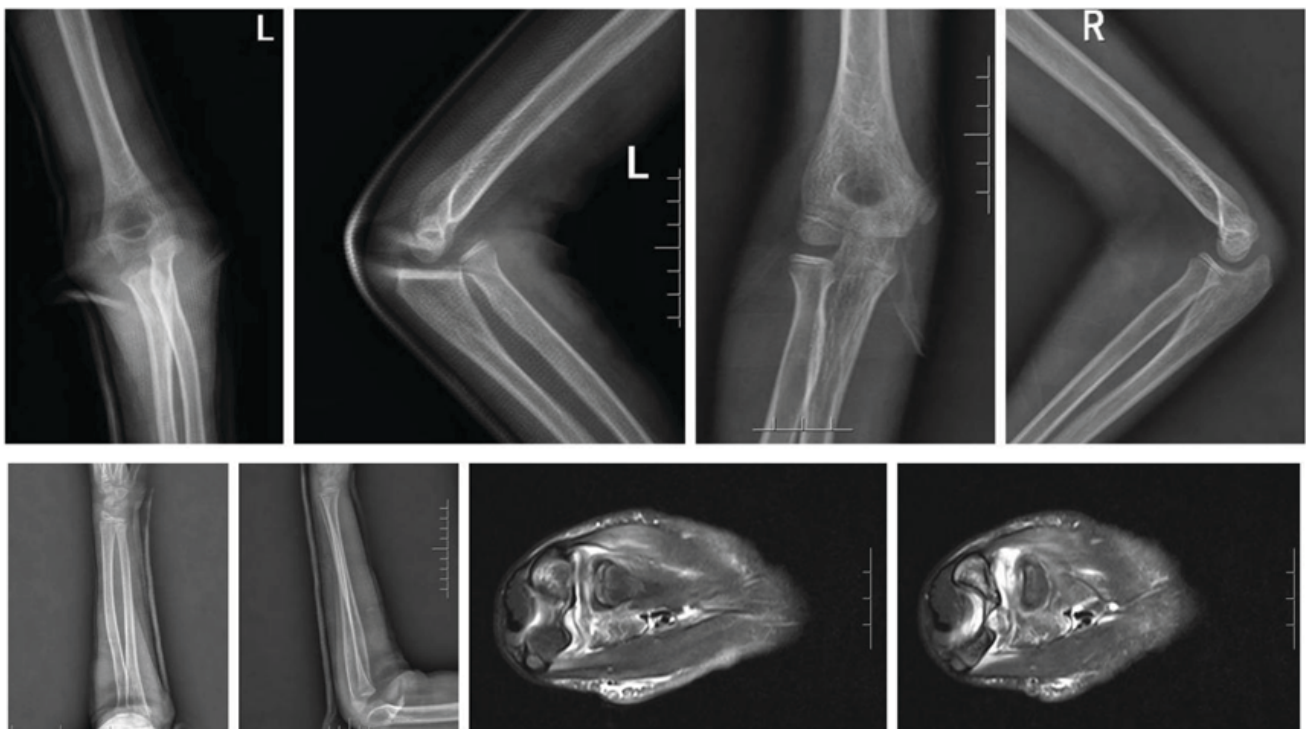


Figure 1. Preoperative radiograph of the left elbow.

Figure 1 shows an anterior dislocation of the left radial head, a left ulnar angulation fracture, and a normal right humeroulnar relationship before surgery.

On August 8, 2023, a proximal ulnar osteotomy was performed on the left side under general anesthesia. The surgical steps were as follows

- (1) The ulnar angulation fracture was reduced using the apex of the ulnar curvature as the fulcrum, but the ulnar deformity could not be corrected.
- (2) 1 ml of iohexol injection was injected into the left elbow joint cavity. C-arm fluoroscopy showed no soft tissue incarceration in the humeroulnar joint. The dislocated radial head was reduced by flexion and

supination manipulation, but the reduction failed.

- (3) A longitudinal incision, approximately 5 cm long, was made on the posterolateral aspect of the proximal left ulna.

The proximal ulnar shaft was exposed in order, and a large amount of bony callus was observed surrounding the proximal ulna. Some of the bony callus was removed. Under C-arm fluoroscopy, the proximal ulnar osteotomy site was marked. After drilling with a Kirschner wire at the osteotomy point, a transverse ulnar osteotomy was performed using a bone knife. The forearm was supinated, and the elbow joint was flexed to the extreme. C-arm fluoroscopy revealed a good reduction of the radial head. The ulnar osteotomy ends were fixed with a set of bone plates and screws. Finally, under C-arm fluoroscopy, the radial head was well-aligned in flexion-supination, flexion-pronation, extension-supination, and extension-pronation (see **Figure 2** for details). After confirming no abnormalities in passive elbow joint movement, the surgical field was routinely irrigated and closed layer by layer. Finally, the left upper limb was immobilized with a plaster cast in 100° flexion and supination.

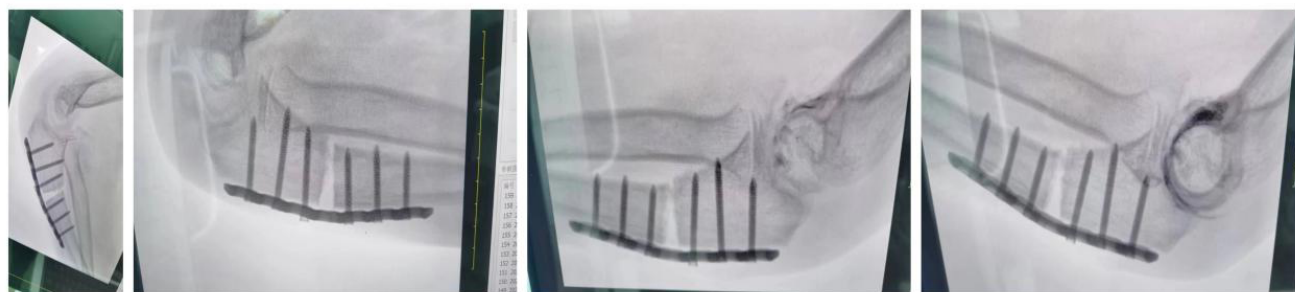


Figure 2. Postoperative radiographic alignment of the humeroulnar joint following proximal ulnar osteotomy.

Figure 2 shows good alignment of the humeroulnar joint in extension-supination, extension-pronation, flexion-supination, and flexion-pronation after proximal ulnar osteotomy and internal fixation during surgery.

On the second postoperative day, X-ray reexamination revealed suboptimal alignment between the radial head and the humeral head, with slight upward displacement of the radial head. The plaster cast was changed to immobilize the left upper limb in 120° flexion and supination. X-ray reexamination showed good humeroulnar alignment (see **Figure 3**).



Figure 3. Radiographic Demonstration of Subluxation Reduction Following Immobilization Adjustment.

Figure 3 shows suboptimal alignment between the radial head and the humeral head, with slight upward

displacement of the radial head on postoperative reexamination. After changing the plaster cast and adjusting the immobilization position, excellent humeroulnar alignment was achieved.

Six weeks after plaster immobilisation, the cast was removed, and the patient was instructed to perform forearm rotation exercises, elbow joint flexion, and extension functional training. Six months after surgery, X-ray reexamination showed satisfactory healing of the ulnar osteotomy ends and satisfactory humeroulnar alignment. After removing the internal fixation, no recurrence of humeral head dislocation was observed (see **Figure 4**). The child's elbow joint flexion, extension, and forearm rotation functions recovered well.

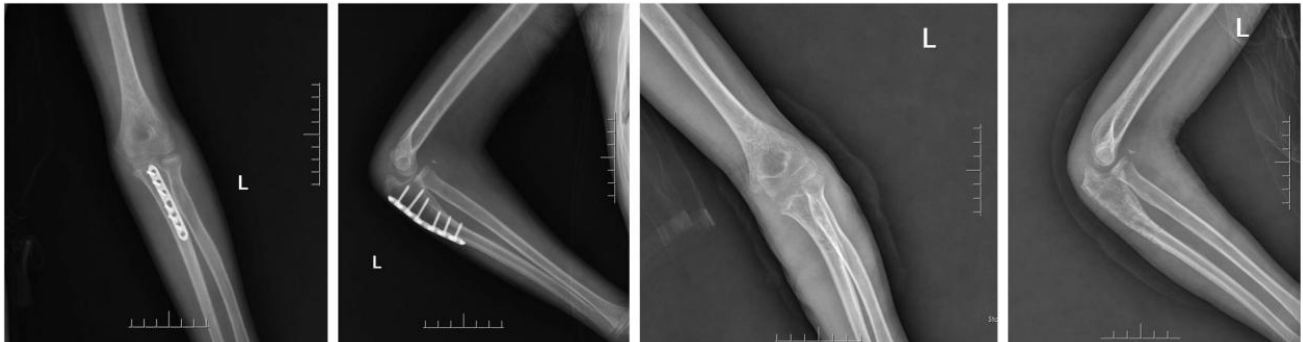


Figure 4. Radiographic confirmation of ulnar union and stable joint alignment after internal fixation removal.

Figure 4 shows satisfactory healing of the ulnar osteotomy ends and satisfactory humeroulnar joint alignment six months after surgery. After removing the internal fixation, excellent humeroulnar joint alignment was maintained on reexamination.

3. Discussion

Monteggia fractures in children were first reported in 1814 by Monteggia, an Italian surgical pathologist from Milan. He described the injury as an ulnar fracture combined with a radial head dislocation and named it Monteggia fracture ^[1]. According to historical research, the understanding of Monteggia fractures has gradually developed. This type of injury is common in skeletally immature minors, especially children aged 4–10 years. Although numerous scholars have conducted in-depth research on the injury mechanism, classification, diagnosis, treatment, and complications of Monteggia fractures, they still pose a challenge for orthopedic surgeons. In 1943, Watson-Jones noted that Monteggia fractures present more challenges than any other type of fracture. He emphasized that no other injury is as complex to manage, and treatment failures are more common with Monteggia fractures compared to other fracture types. However, the early symptoms of chronic Monteggia fractures are less typical and easily missed. Chronic Monteggia fractures cause persistent abnormalities in the elbow joint structure, potentially leading to elbow pain, limited movement, cubitus valgus, and ulnar neuritis ^[2]. The surgical determination and treatment of chronic Monteggia fractures are far more complex than acute injuries.

Type I Monteggia fracture is the most common type of Monteggia injury. Its mechanism mainly includes direct violence, excessive rotation, and hyperextension theories. Based on the patient's ulnar fracture type and body position at the time of injury, the injury mechanism was speculated to be a hyperextension injury. When the patient fell, the forearm was extended, and the elbow joint was hyperextended. Under the action of the biceps brachii, the radius first dislocated anteriorly, forcing it to leave the humeral capitellum. Simultaneously, the body

weight acted on the ulna, and the ulna could not withstand the longitudinal violence of the body weight, resulting in a green-stick fracture of the ulnar shaft ^[3]. (The injury mechanism is shown in **Figure 5**.)

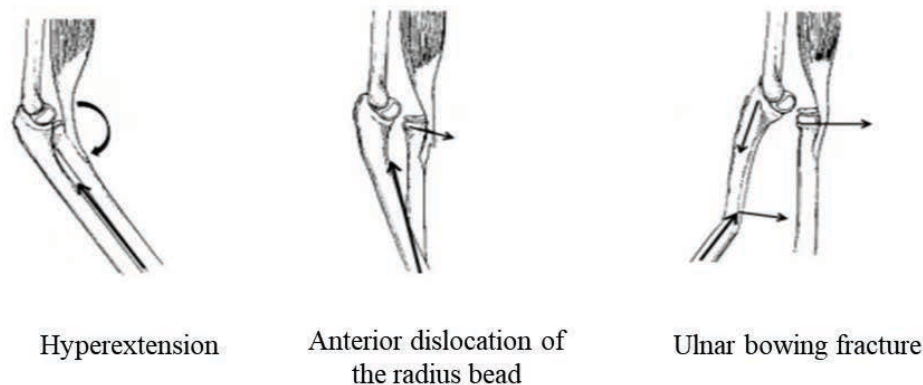


Figure 5. Schematic of the injury sequence.

Monteggia fractures in children are often misdiagnosed or missed due to various factors. First, the clinical symptoms primarily manifest as soft tissue injuries of the forearm, and primary care physicians may have a limited understanding of the injury mechanisms and characteristics specific to pediatric Monteggia fractures. Additionally, children may struggle to accurately describe the location of their pain or cooperate during physical examinations, leading to unclear descriptions of the injury details. Furthermore, radiographic imaging may not include the elbow joint, contributing to misdiagnosis or missed diagnosis. As a result, the rate of missed diagnoses in pediatric Monteggia fractures is relatively high. If prompt treatment is not provided for acute Monteggia fractures, prolonged dislocation of the radial head can gradually evolve into chronic Monteggia fractures. As the condition progresses over time, continuous changes occur in the soft tissue structures within the elbow joint, resulting in complications such as deformity healing of the ulnar fracture ends, persistent radial head dislocation, interosseous membrane contracture, nerve paralysis, and heterotopic ossification of the elbow joint ^[4]. These complications pose significant challenges for subsequent treatment.

With the increasing attention given to chronic Monteggia fractures, diagnostic and treatment methods have undergone innovation and improvement. Researchers have summarized existing literature to analyze the progress in treating chronic Monteggia fractures, providing a basis for diagnosis and treatment. For timely diagnosed Monteggia fractures still in the early acute stage, many scholars recommend closed reduction and plaster fixation treatment. This is because most acute Monteggia fractures achieve stable humeroradial joints after successful reduction. However, for patients with failed manual reduction and a longer disease course, the pathological characteristics align with chronic Monteggia fractures ^[5]. Persistent, long-term dislocation of the radial head in children is one of the main manifestations of chronic Monteggia fractures. Researchers have observed in clinical practice that many children's daily elbow joint function is not significantly affected by radial head dislocation, leading to reduced vigilance among patients and their families due to the minimal restriction in elbow joint functional activity. However, as time progresses and the disease course persists, complications emerge, including increased instability of the proximal radioulnar joint, joint degeneration, healing of ulnar deformity, osteoarthritis, and ulnar neuritis. Therefore, even if elbow joint function is essentially unrestricted in children with chronic Monteggia fractures, early surgical treatment is still recommended to prevent numerous complications later on.

The purpose of treating chronic Monteggia fractures in children is to restore the stability of the proximal radioulnar joint and improve elbow joint function by reducing the radial head. Currently, there are numerous treatment options reported in the literature, but no consensus has been reached. Treatment methods mainly focus on radial head reduction, annular ligament repair and reconstruction, elbow joint release, joint capsule scar debridement, ulnar osteotomy, adjusting the direction and length of the ulnar osteotomy end, internal fixation or external fixation, and other issues ^[6,7]. Some scholars believe that the annular ligament is the foundation for ensuring the stability of the proximal radioulnar joint, so the annular ligament should be routinely reconstructed. Other scholars believe that one-stage ulnar osteotomy with plate internal fixation combined with elbow joint release, annular ligament cerclage, and joint capsule reconstruction can achieve satisfactory results, and early functional exercise can be performed postoperatively, avoiding the inconvenience of external fixator care ^[8]. Eevi et al. showed that the stability of the radial head mainly depends on the posterior angulation and elongation obtained after ulnar osteotomy, and annular ligament reconstruction is not necessary ^[9]. Langenberg et al. pointed out that improper annular ligament reconstruction may adversely affect the later development of the radial head and the stability of the proximal radioulnar joint ^[10]. Numerous studies have shown that ulnar osteotomy and elongation are crucial steps in the treatment of chronic Monteggia fractures. Due to the good blood supply at the metaphyseal end of the ulna, it has strong healing abilities. In addition, osteotomy at the proximal ulna helps to keep the original interosseous membrane tension as high as possible. This gives the proximal radioulnar joint and the humeroradial joint even more stability after reduction. Therefore, an ulnar osteotomy is performed at the proximal end. After the osteotomy is completed, the radial head can be reduced to the correct position by using a large osteotomy angle and the tension of the interosseous membrane.

4. Conclusion

Ulnar osteotomy is an effective treatment for Monteggia fractures in children ^[11]. In this case, favorable therapeutic effects were achieved through a simple proximal ulnar osteotomy. Early diagnosis of Monteggia fractures in children is critical for avoiding chronic fractures and reducing subsequent complications. In clinical practice, doctors need to pay more attention to the diagnosis and treatment of fractures in children, improve their understanding of Monteggia fractures, and develop personalized treatment plans based on the specific conditions of the child. In this patient, we performed a simple proximal ulnar lengthening osteotomy with plate internal fixation. An intraoperative fluoroscopy confirmed a good reduction of the radial head. A postoperative radial head subluxation was found, which was improved by pronation of the forearm and increasing the elbow flexion angle to improve the alignment of the humeroradial joint. Six months postoperatively, good healing of the ulnar osteotomy site and good humeroradial alignment were observed. After the internal fixation was removed, good humeroradial alignment was maintained, resulting in favorable therapeutic effects. The limitation of this study lies in the small sample size, requiring further expansion of the sample size for more in-depth research and validation.

Disclosure statement

The authors declare no conflict of interest.

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Mediating Effects of Knowledge, Attitudes, and Practice of Rehabilitation on the Relationship between Fatigue and Kinesiophobia in Patients with Coronary Heart Disease

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Abstract: This study aimed to investigate the mediating role of knowledge, attitude, and practice (KAP) in the relationship between fatigue and kinesiophobia in 200 coronary heart disease patients from three Chinese tertiary hospitals. Using validated scales (MFSI-SF, TSK-SV Heart, and the Rehabilitation Exercise Knowledge-Attitude-Practice Scale for Patients), data analysis via SPSS 25.0 and AMOS 24.0 structural equation modeling identified a significant KAP-mediated pathway (total indirect effect = 0.377). KAP of rehabilitation was significantly negatively correlated with fatigue ($r = -0.51$, $p < 0.01$) and kinesiophobia ($r = -0.60$, $p < 0.01$), whereas fatigue was significantly positively correlated with kinesiophobia ($r = 0.678$, $p < 0.01$). Results indicate that fatigue amplifies kinesiophobia by compromising KAP of rehabilitation. A significant mediating effect of KAP of rehabilitation on the relationship between fatigue and kinesiophobia was found. Improving patient fatigue and the knowledge, attitudes, and practices of rehabilitation can help reduce kinesiophobia.

Keywords: Coronary heart disease; Fatigue; Kinesiophobia; KAP of rehabilitation

Online publication: Dec 31, 2025

1. Introduction

Coronary heart disease (CHD) is a global health challenge characterized by high morbidity, mortality, and long-term complications, significantly impairing patients' quality of life. Coronary heart disease affects 197 million people worldwide, with the number of deaths increasing to 9.1 million^[1]. Therefore, coronary heart disease is an important challenge that needs to be solved in the world's public health. Exercise-based cardiac rehabilitation is recognized as a key component of comprehensive CHD management. Previous studies have demonstrated that participation in exercise-based cardiac rehabilitation can reduce cardiovascular disease mortality and hospitalization rates, modify risk factors, and improve quality of life^[2,3].

Although the guidelines recommend cardiac rehabilitation for patients with cardiovascular disease, according to the available literature, the implementation of cardiac rehabilitation is not good worldwide. The enrollment rate for a cardiac rehabilitation program following STEMI is approximately 25–35% in Western countries and only 15% in Italy ^[4]. Many centers experienced challenges with long-term adherence, as 58% of patients discontinued participation in an exercise program within 8 to 9 months ^[5].

Studies have shown that kinesiophobia is the main factor affecting patients' cardiac rehabilitation, which has a negative impact on the outcome of rehabilitation in CHD patients ^[6]. Kinesiophobia is defined as a patient's excessive, irrational fear or avoidance state toward exercise due to the fear of injury to the body ^[7]. Kinesiophobia is frequently observed in individuals diagnosed with CHD. More than 70% of CHD patients have different degrees of kinesiophobia ^[8]. Kinesiophobia can lead to negative emotions and reduced quality of life ^[9]. According to the fear-avoidance model, patients avoid exercise and reduce physical activity, which decreases muscle strength and other conditions to further aggravate kinesiophobia ^[10].

The knowledge, attitude, and practice (KAP) of rehabilitation is used to assess the status quo of knowledge, attitudes and practices related to rehabilitation exercise among patients with CHD. The level of engagement in exercise-based cardiac rehabilitation in patients with CHD is generally closely related to patients' knowledge, attitudes and practices ^[11].

The greater the level of KAP of rehabilitation, the lower the level of kinesiophobia ^[12]. Fatigue, a common symptom in patients with CHD, is a persistent and subjective feeling of tiredness accompanied by a decrease in physical strength and cannot be relieved by rest ^[13]. Fatigue is one of the causes of sudden cardiac death, which leads to increased mortality and affects patients' cognitive ability and quality of life ^[14,15]. Studies have shown that the occurrence of moderate to severe fatigue in patients with CHD reaches 39% during cardiac rehabilitation and remains as high as 28% after 1 year ^[16].

A study of 263 patients with heart failure revealed that fatigue was a significant factor in kinesiophobia, and patients with more intense fatigue were found to have higher levels of kinesiophobia ^[17]. When patients experience physical or mental fatigue, they often choose to avoid exercise.

Studies have shown that fatigue and KAP of rehabilitation are important factors in kinesiophobia ^[12,17]. The fear-avoidance model refers to a change in physical conditions (pain, discomfort, fatigue, etc.) so that the patient stimulates the body to experience kinesiophobia through psychological factors, individual coping strategies and other variables ^[18]. This model of cognitive behavior is often used to explain kinesiophobia.

According to the fear-avoidance model, kinesiophobia is the behavior of avoiding exercise on the basis of psychological cognitive changes. Therefore, through a literature review, this study aims to explore whether the KPA of rehabilitation plays a mediating role in the relationship between fatigue and kinesiophobia to provide a theoretical basis for formulating targeted intervention strategies to improve patients' participation in cardiac rehabilitation and quality of life. On the basis of the fear-avoidance model, this study proposed the following hypothesis

- (1) KAP of rehabilitation in CHD patients is significantly negatively correlated with kinesiophobia, and fatigue is significantly positively correlated with kinesiophobia.
- (2) Fatigue can directly affect kinesiophobia and can also indirectly affect kinesiophobia by affecting KAP of rehabilitation.

2. Methods

2.1. Design and sample

A multicenter cross-sectional questionnaire survey was carried out in the cardiology departments of three tertiary hospitals located in Shiyan City, Hubei Province, from October 1 to November 31, 2024. Convenience sampling was chosen because of feasibility constraints in clinical settings. Patients were included if they

- (a) Had a confirmed clinical diagnosis of CHD
- (b) Were aged ≥ 18 years
- (c) Were able to understand and speak Chinese
- (d) Had a heart function classification of no more than Grade III

Patients were excluded if they had

- (a) Cognitive dysfunction resulting in an inability to answer the questionnaires
- (b) Organic lesions of important organs
- (c) Limb motor dysfunction caused by various factors and not fully recovering to normal

Data collection was conducted face-to-face by trained researchers. For participants with limited literacy, questionnaires were administered verbally, and responses were recorded by the researchers. Each interview lasted approximately 30–40 minutes.

2.2. Instruments

This study utilized a self-designed questionnaire to gather sociodemographic information from participants, such as their gender, age, marital status, level of education, monthly household income, occupation, etc.

The level of fatigue in patients was evaluated via the Multidimensional Fatigue Inventory developed by Smets et al.^[19] The scale comprises a total of 20 items organized into five distinct dimensions: general fatigue, physical fatigue, mental fatigue, reduced motivation and reduced activity. Using the 5-point Likert scale, the scale's total score ranges from 20–100, with higher scores indicating higher levels of fatigue. The scale has demonstrated strong reliability and validity, with a Cronbach's α of 0.84^[19]. For this sample, the Cronbach's α for the scale was 0.915.

The Tampa Scale for Kinesiophobia Heart Compiled by Bäck et al.^[20] In 2019, Chinese scholar Mengjie Lei revised it into a Chinese version of the Tampa Scale for Kinesiophobia Heart. The Cronbach's α coefficient of the revised scale was 0.859. The scale comprises a total of 20 items organized into four distinct dimensions: perceived danger for heart problems, avoidance of exercise, fear of injury and dysfunctional self. The total score ranges from 17 to 68 points. The higher the score is, the greater the level of kinesiophobia. For this sample, the Cronbach's α for the scale was 0.827.

The rehabilitation exercise knowledge-attitude-practice scale for patients with CHD was developed by Mengli Zhao^[21]. There are 3 dimensions and 23 items, including knowledge, attitudes and practices. The higher the score is, the greater the level of knowledge of rehabilitation exercise, the more positive the attitude toward rehabilitation exercise, and the greater the level of rehabilitation exercise behavior. This scale showed good reliability, with a Cronbach's α of 0.833. For this sample, the Cronbach's α for the scale was 0.924.

2.3. Ethical considerations

The research received approval from the Non-Invasive Ethics Committee of Hubei University of Medicine (Approval No: 2024-RE-027). The purpose and significance of the study were explained to the participants before the questionnaire survey. After providing written informed consent, the participants in the study were invited to

fill out the questionnaire anonymously. The participants' personal information and completed questionnaires were sealed to ensure their privacy.

2.4. Statistical analysis

For the data analysis in this study, SPSS 25.0 and Amos 24.0 statistical software were used. The demographic variables are displayed as the means and standard deviations, whereas count data are reported as frequencies and percentages.

Pearson's coefficient was used to assess the correlation between the KAP of rehabilitation, kinesiophobia and fatigue. The Harman single-factor test was used to assess common method bias, with a critical value of 40%. The mediating effect of KAP of rehabilitation was examined via Amos 24.0. In the mediation model, fatigue was the independent variable, kinesiophobia was the dependent variable, and KAP of rehabilitation was the mediator. The mediation analyses were tested with 2000 bootstrapping samples and 95% confidence intervals (95% CI). The level of statistical significance was set at $p < 0.05$.

3. Results

3.1. Common method bias test

The data in this study were obtained via self-reports, which could potentially introduce common method bias.

To improve the rigor of the study, all items of the questionnaire in this study were included in the analysis via Harman's single factor test. The findings indicated that 14 factors had a value greater than 1 (**Table 1**), and the first common factor explained 26.73% of the total variance, which fell below the threshold of 40%. Therefore, there was no significant common method bias in the data of this study.

Table 1. Common factors with eigenvalues greater than 1 (N = 200)

Components	Total	Percent variance of the initial eigenvalues	Cumulation %	Total	Extract the load squared sum variance percentage	Cumulation %
1	16.037	26.728	26.728	16.037	26.728	26.728
2	4.93	8.217	34.945	4.93	8.217	34.945
3	2.546	4.243	39.188	2.546	4.243	39.188
4	2.392	3.987	43.174	2.392	3.987	43.174
5	2.117	3.528	46.702	2.117	3.528	46.702
6	1.88	3.133	49.835	1.88	3.133	49.835
7	1.679	2.799	52.634	1.679	2.799	52.634
8	1.668	2.78	55.413	1.668	2.78	55.413
9	1.435	2.392	57.805	1.435	2.392	57.805
10	1.355	2.258	60.064	1.355	2.258	60.064
11	1.19	1.983	62.047	1.19	1.983	62.047
12	1.16	1.933	63.98	1.16	1.933	63.98
13	1.091	1.819	65.799	1.091	1.819	65.799
14	1.055	1.758	67.558	1.055	1.758	67.558

3.2. Sample characteristics

The study included a total of 200 patients who were diagnosed with CHD. The sociodemographic characteristics are shown in **Table 2**. Notably, 97.5% of the patients were over 45 years old, and 53% of the patients were men. A total of 48.5% of the patients had a primary or lower education and were married (92%). In this study, the KAP for the rehabilitation of patients with CHD was 44.61 ± 12.10 . The fatigue score was 57.91 ± 11.53 . The kinesiophobia score was 43.12 ± 5.13 .

Table 2. Demographic and clinical characteristics (N = 200)

Variable	N (%)
Gender	
Male	106(53)
Female	94(47)
Age	
18–45	5(2.5)
46–59	45(22.5)
60–75	101(50.5)
> 75	49(24.5)
Education level	
Uneducated	35(17.5)
Primary School	62(31)
Junior High School	56(28)
High School	27(13.5)
College and above	20(10)
Marital status	
Married	184(92)
Unmarried, Divorced or Widowed	16(8)
Place of residence	
Villages	59(29.5)
Towns, Counties or Cities	141(70.5)
Average monthly income (RMB, yuan)	
< 5000	46(23)
5000–10000	141(70.5)
> 10000	13(6.5)

3.3. Correlation analysis

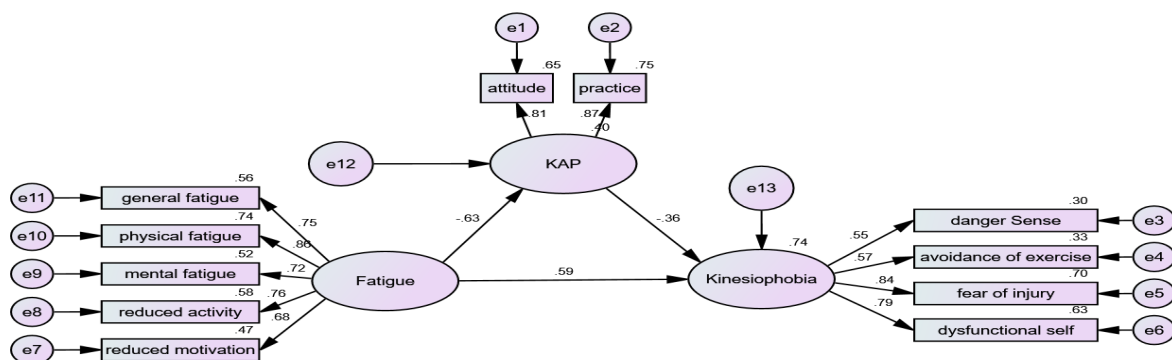
Pearson correlations were used to examine the associations among the three variables of the KAP of rehabilitation, fatigue, and kinesiophobia, and the correlations of various variables are shown in **Table 3**. KAP of rehabilitation was significantly and negatively correlated with fatigue ($r = -0.51, p < 0.01$) and kinesiophobia ($r = -0.60, p < 0.01$), whereas fatigue was significantly and positively correlated with kinesiophobia ($r = 0.678, p < 0.01$).

Table 3. Correlation analysis of KAP of rehabilitation, fatigue, and kinesiophobia (n = 200)

Variable	M ± SD	The KAP of rehabilitation	Fatigue	Kinesiophobia
The KAP of rehabilitation	44.61 ± 12.10	1		
Fatigue	57.91 ± 11.53	-.512**	1	
Kinesiophobia	43.12 ± 5.13	-.600**	.678**	1

M: mean; SD: standard deviation. ** $p < 0.01$.

The study established a structural equation model, with fatigue as the independent variable, kinesiophobia as the dependent variable, the KAP of rehabilitation as the mediating variables, and all variables were standardized. The mediation model is shown in **Figure 1**. Structural equation model fitting index: CMIN/DF = 2.508, GFI = 0.916, AGFI = 0.865, RMSEA = 0.087, NFI = 0.911, NNFI=0.924, indicating that the model fits well. The model effect size results are shown in **Table 4**, fatigue had direct predicted of kinesiophobia ($\beta = 0.27$, $p = 0.001$). In addition, kinesiophobia can be predicted indirectly through the KAP of rehabilitation ($\beta = 0.106$, $p = 0.001$). All the 95%CI for the effect sizes of all paths did not include 0, indicating that all paths were statistically significant. The KAP of rehabilitation has a partial mediating effect between fatigue and kinesiophobia.

**Figure 1.** The mediation model.**Table 4.** The mediating effects of fatigue on the relationships among knowledge, attitudes, practice of rehabilitation and kinesiophobia

Effect	Item	β	p	95% CI
Direct effect	Fatigue → Kinesiophobia	0.27	0.001	0.168–0.415
Indirect effect	Fatigue → The KAP of Rehabilitation → Kinesiophobia	0.106	0.001	0.054–0.184
Total effect	Fatigue → Kinesiophobia	0.377	0.001	0.267–0.503

β : standardized beta; CI: confidence interval

4. Discussion

In this study, the score of kinesiophobia in patients with CHD was 43.12 ± 5.13 , and the fatigue score was 57.91 ± 11.53 , which was moderate. This finding is consistent with previous findings on fatigue and kinesiophobia in CHD patients^[16,22]. CHD patients avoid exercise because they are afraid of disease recurrence, death, or increased heart rate during exercise. Patients with coronary heart disease are affected by disease factors such as dyspnea and chest pain, which can lead to anxiety, depression and other negative emotions and are more likely to experience physical and mental decline, leading to fatigue^[23]. In this study, the KAP score for rehabilitation in patients with CHD was 44.61 ± 12.10 , which was lower than that reported by Feng Qingjing et al.^[12]. The reason may be that the proportion of patients over 60 years old in this study was as high as 75%. Owing to the decline in memory and cognitive function, the level of KAP associated with rehabilitation in patients is not high.

This study revealed that kinesiophobia was positively correlated with fatigue ($r = 0.678$, $p < 0.01$). According to the fear-avoidance model, when individuals face pain, discomfort and other stimuli, they experience kinesiophobia and actively avoid physical activity^[18]. Patients with coronary heart disease are affected by physical fatigue and psychological fatigue, resulting in kinesiophobia. The greater the degree of fatigue is, the greater the level of kinesiophobia. These results are consistent with those of previous studies^[24,25]. Previous studies on fatigue-related exercise fear in 236 patients with heart failure have shown that severe fatigue may lead to increased levels of kinesiophobia^[17]. Fatigue easily causes patients to have negative emotions^[26]. The greater the level of negative emotions is, the more patients avoid exercise^[27]. In addition, the KAP score of rehabilitation in patients with CHD was negatively correlated with kinesiophobia ($r = -0.600$, $p < 0.01$). These results are consistent with those of previous studies^[12]. Patients' exercise rehabilitation behavior is generally closely related to patients' knowledge, attitudes and behavior^[11,28]. The more patients know about rehabilitation exercise, the more positive their attitude toward it, the greater their likelihood of performing rehabilitation exercise, and the lower their level of kinesiophobia.

The mediating effect model tested via the bootstrap method revealed that the KAP score of rehabilitation partially mediated the relationship between fatigue and kinesiophobia in patients with CHD. Fatigue had a direct predictive effect on kinesiophobia in patients with CHD, and it could also indirectly predict kinesiophobia through KAP of rehabilitation; the mediating effect was 28.12%. The fear-avoidance model posits that maladaptive cognitive responses to somatic sensations (e.g., fatigue) amplify avoidance behaviors. In CHD patients, this may manifest as kinesiophobia due to misinterpretation of exercise-related symptoms as threatening. Reducing the fatigue level of patients with coronary heart disease is beneficial for enhancing patients' confidence in rehabilitation exercise and reducing kinesiophobia. Fatigue is a multidimensional subjective feeling of fatigue, including physiological, psychological and cognitive aspects^[19]. The disease restricts patients' daily activities, resulting in physical fatigue. Coronary heart disease has a long course and a heavy disease burden. Patients may experience negative emotions, exacerbating their psychological fatigue. Physical fatigue can affect the speed and endurance of patients during exercise, resulting in slow movement and affecting their exercise ability^[29]. Studies have shown that patients are more likely to perform rehabilitation exercises when they are in good physical condition^[30]. In addition, patients often choose negative coping styles such as avoidance when they have a bad psychological state^[31]. Patients with coronary heart disease affected by psychological fatigue have a negative attitude toward rehabilitation. A higher level of fatigue may reduce patients' desire to actively seek learning knowledge, resulting in a low level of rehabilitation exercise knowledge. Therefore, medical staff can reduce the fatigue level of patients through psychological intervention to improve their KAP level of rehabilitation.

When patients with CHD have a greater KAP level of rehabilitation, they have a deeper understanding of disease knowledge to be better able to experience the benefits of exercise, have a more positive attitude, have greater exercise compliance, and have less kinesiophobia. Therefore, medical staff should strengthen their knowledge education, emphasize the important role of exercise in the secondary prevention of CHD, help patients establish exercise beliefs, reduce fatigue and kinesiophobia, and increase their enthusiasm for exercise rehabilitation.

5. Limitations

The study used convenience sampling, the sample size was small, and the representativeness of the sample was limited, which could not better represent the overall level. Moreover, this study was a multicenter cross-sectional study at a single time point, and it could not longitudinally track the relationship between the changes in each variable over time. Moreover, considering fatigue as a partial mediator, future research can employ multicenter stratified sampling with a large sample size to investigate the impact of other variables.

6. Conclusion

This multicenter cross-sectional study explored the relationships among KAP of rehabilitation, fatigue, and kinesiophobia. The results of this study confirmed that KAP of rehabilitation partially mediated the relationship between fatigue and kinesiophobia in patients with CHD. These findings provide a reference for the development of effective intervention measures for kinesiophobia. Medical staff should pay attention to patients' disease-related knowledge support and improve patients' KAP toward rehabilitation to reduce patients' fatigue and kinesiophobia.

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Disclosure statement

The authors declare no conflict of interest.

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Research on the Clinical Correlation Between the Detection of Irregular Antibodies in Red Blood Cell Blood Groups and Hemolytic Disease of the Newborn

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Abstract: *Objective:* To explore the clinical correlation between the detection of irregular antibodies in red blood cell blood groups and hemolytic disease of the newborn. *Methods:* This study selected newborns who underwent examinations and were diagnosed with hemolytic disease at our hospital from October 2024 to October 2025 as the research subjects. Based on the severity of their hemolytic disease, the infants were divided into a severe group and a mild group. All the infants underwent detection for irregular antibodies in their red blood cell blood groups. General information, blood types, and irregular antibody test results of the two groups were recorded. Univariate analysis was conducted, and variables with statistical significance from the univariate analysis were included in a multivariate logistic regression analysis to explore the clinical correlation between the detection of irregular antibodies in red blood cell blood groups and hemolytic disease of the newborn. *Results:* Through univariate analysis, it was found that IgG1 and IgG3 subclass antibodies, as well as ABO blood group incompatibility, were statistically significant ($p < 0.05$). When these factors were included in a multivariate logistic regression analysis, it was discovered that IgG1 (OR = 2.461, 95% CI: 1.859–2.709), IgG3 (OR = 2.509, 95% CI: 1.918–2.893), and ABO blood group incompatibility (OR = 2.998, 95% CI: 2.149–3.493) all exhibited a positive correlation with hemolytic disease of the newborn. *Conclusion:* As levels of IgG1, IgG3, and ABO blood group incompatibility increase, the incidence of hemolytic disease of the newborn also rises, warranting clinical attention.

Keywords: Red blood cell blood group; Irregular antibody detection; Newborn; Hemolytic disease; Correlation analysis

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1. Introduction

Hemolytic Disease of the Fetus and Newborn (HDFN) is a common immune-mediated disorder in clinical practice, primarily caused by maternal-fetal blood group incompatibility. IgG antibodies produced in the maternal

body can cross the placenta and enter the newborn's circulation, sensitizing the newborn's red blood cells. The main clinical symptoms include hepatosplenomegaly, hyperbilirubinemia, and, in severe cases, kernicterus and even death^[1]. Based on the differences in red blood cell surface antigens within the blood group system, there are certain variations in clinical manifestations. Some studies have indicated that the severity of hemolytic disease is somewhat correlated with the rate of red blood cell destruction^[2]. In cases of ABO blood group incompatibility involving O-type mothers and non-O-type infants, the primary reason is that O-type blood can produce antibodies against A and B antigens, although the exact mechanism remains unclear. It is currently widely believed that substances within A and B antigens in the natural environment can stimulate the body, leading to the production of anti-A and anti-B antibodies^[3]. ABO blood group antigens are not only present on red blood cells but also widely distributed throughout various tissues in the human body. In clinical practice, the diagnosis and treatment of hemolytic disease of the newborn (HDN) face multiple challenges. Firstly, HDN symptoms caused by ABO blood group incompatibility are usually mild, whereas HDN caused by Rh blood group incompatibility or other rare blood group systems may progress rapidly and require early intervention. Secondly, traditional HDN diagnosis relies on the direct antiglobulin test, free antibody test, and antibody release test; however, these methods have limited sensitivity in detecting low-titer antibodies or antibodies from non-ABO blood group systems^[4]. Additionally, while the treatment methods for Hemolytic Disease of the Newborn (HDN) can effectively reduce bilirubin levels, they cannot reverse brain damage that has already occurred. Therefore, early prevention and precise diagnosis become crucial in reducing the harm caused by HDN^[5]. Based on this, this study selected newborns who were examined and diagnosed with hemolytic disease in our hospital from October 2024 to October 2025 as the research subjects, and explored the clinical correlation between the detection of irregular antibodies to red blood cell blood groups and neonatal hemolytic disease. The specific report is as follows.

2. Materials and methods

2.1. General information

This study selected a total of 100 newborns who were examined and diagnosed with hemolytic disease in our hospital from October 2024 to October 2025 as the research subjects.

2.1.1. Inclusion criteria

- (1) Age at birth ≤ 30 days
- (2) Complete clinical data
- (3) Completion of three tests for neonatal hemolytic disease with complete data
- (4) The family members of the newborns signed informed consent forms, indicating their voluntary participation in this study

2.1.2. Exclusion criteria

- (1) Concomitant with other immune diseases
- (2) History of immunotherapy
- (3) Presence of congenital red blood cell defects

2.2. Methods

2.2.1. Blood group antibody detection

Conduct ABO and RhD blood group typing, and use microcolumn gel test cards for labeling. Add 50 μL of red blood cell suspension into microwells 1–4, and add maternal serum into microwell 5. Add standard A and B red blood cell suspensions. After completion, centrifuge at 900 rpm for 2 minutes, and then interpret the results. Result interpretation: Specific antigen-antibody complexes formed between red blood cell antigens and corresponding antibodies in the microcolumn gel float on the gel surface or within the gel ^[6].

Subsequently, perform irregular antibody screening with the following specific steps

- (1) Label the microcolumn gel test cards
- (2) Add 50 μL of a 0.5–0.8% standard O red blood cell suspension into tubes 1–6
- (3) Add the serum to be tested into tubes 1–5
- (4) After sample addition, place the test cards into a 37°C incubator and immediately centrifuge using a dedicated serological centrifuge at 900 rpm for 2 minutes, then interpret the results ^[7]
- (5) Result interpretation: If tubes 1–5 show negative results, the serum does not contain standard O red blood cell antigen-specific IgG incomplete antibodies.

2.2.2. Research methods

A total of 100 pediatric patients were included in this study and were divided into a milder group and a more severe group based on their conditions, which were regarded as the dependent variables. The independent variables selected were general information, blood type, and irregular antibody test results.

2.3. Statistical methods

In this study, statistical software SPSS 21.00 was utilized for data processing and calculation during data comparison. The chi-square test was employed for measurement data, expressed as (n, %), while the *t*-test was used for count data, expressed as ($\bar{x} \pm s$). Variables with statistical significance identified through univariate analysis were included in multivariate logistic analysis. A calculated result with $p < 0.05$ indicated that the difference was statistically significant.

3. Results

3.1. Analysis of general information

A total of 100 pediatric patients were included in this study, comprising 56 male patients (56.00%) and 44 female patients (44.00%). The average age in days was (13.24 ± 3.47) d, with an average birth weight of (3.84 ± 1.06) kg and an average birth length of (54.06 ± 8.94) cm. In antibody tests, the mean IgG1 level was (2.64 ± 0.71)%, IgG2 was (80.97 ± 9.06)%, IgG3 was (11.58 ± 3.23)%, and IgG4 was (6.24 ± 1.25)%. There were 17 cases (17.00%) of ABO blood group incompatibility, as detailed in **Table 1**.

Table 1. Analysis of general data results

Variable	Category	Result
Gender [n(%)]	Male	56 (56.00)
	Female	44 (44.00)
Age (days)	Mean \pm SD	13.24 \pm 3.47
Weight (kg)	Mean \pm SD	3.84 \pm 1.06
Length (cm)	Mean \pm SD	54.06 \pm 8.94
IgG1 (%)	Mean \pm SD	2.64 \pm 0.71
IgG2 (%)	Mean \pm SD	80.97 \pm 9.06
IgG3 (%)	Mean \pm SD	11.58 \pm 3.23
IgG4 (%)	Mean \pm SD	6.24 \pm 1.25
ABO incompatibility [n(%)]	Cases	17 (17.00)

3.2. Analysis of univariate results

In this study, 67 patients were included in the milder group and 33 in the more severe group. Univariate analysis revealed that IgG1 and IgG3 subclass antibodies, as well as ABO blood group incompatibility, were statistically significant ($p < 0.05$). Other variables did not show statistical significance, as detailed in **Table 2**.

Table 2. Analysis of univariate results

Variable	Category	Mild group (n = 67)	Severe group (n = 33)	Statistical value (χ^2/t)	p-value
Gender [n]	Male (n = 56)	36	20	0.424	0.515
	Female (n = 44)	31	13		
Age (days)	Mean \pm SD	13.50 \pm 3.45	13.13 \pm 3.51	0.501	0.617
Weight (kg)	Mean \pm SD	3.88 \pm 1.08	3.83 \pm 1.05	0.220	0.827
Length (cm)	Mean \pm SD	54.01 \pm 9.03	54.16 \pm 9.01	0.078	0.938
IgG1 (%)	Mean \pm SD	2.52 \pm 0.69	3.26 \pm 0.67	5.091	< 0.001
IgG2 (%)	Mean \pm SD	78.29 \pm 7.93	83.67 \pm 8.04	3.176	0.002
IgG3 (%)	Mean \pm SD	11.54 \pm 3.26	11.59 \pm 3.29	0.043	0.966
IgG4 (%)	Mean \pm SD	6.26 \pm 1.23	6.23 \pm 1.20	0.116	0.908
ABO incompatibility [n(%)]	Cases (n = 17)	7	10	6.178	0.013

3.3. Multivariate logistic regression analysis

Variables that were statistically significant in the above univariate analysis were included in the multivariate logistic regression analysis, specifically incorporating three variables: IgG1, IgG2, and ABO blood group incompatibility. The multivariate analysis revealed that IgG1 (OR = 2.461, 95%CI: 1.859–2.709), IgG3 (OR = 2.509, 95%CI: 1.918–2.893), and ABO blood group incompatibility (OR = 2.998, 95%CI: 2.149–3.493) all exhibited a positive correlation with hemolytic disease of the newborn (HDN). The specific data are presented in **Table 3**.

Table 3. Multivariate logistic regression analysis

Variable	β	S.E.	<i>p</i> -value	OR	95% CI
IgG1	0.90	0.87	< 0.05	2.461	1.859–2.709
IgG2	0.93	0.92	< 0.05	2.509	1.918–2.893
ABO incompatibility	0.97	0.94	< 0.05	2.998	2.149–3.493

4. Discussion

The detection of irregular antibodies to red blood cell blood groups is a crucial step in preventing hemolytic disease of the newborn. Irregular antibodies refer to blood group antibodies other than anti-A and anti-B, primarily induced by exposure to foreign red blood cells through events such as blood transfusion, pregnancy, or transplantation^[8]. These antibodies can cross the placenta into the fetal bloodstream, bind to antigens on the surface of fetal red blood cells, and trigger immune-mediated hemolytic reactions. Prenatal screening for irregular antibodies can identify in advance whether antibodies that may cause HDN are present in the pregnant woman's body^[9,10]. For antibody-positive pregnant women, the risk of fetal hemolysis can be assessed through regular monitoring of antibody titers and fetal ultrasound examinations. When necessary, intrauterine transfusion or early termination of pregnancy can be performed^[11]. Irregular antibody testing is also an important screening item before blood transfusion. If a pregnant woman requires a blood transfusion, this testing can prevent the transfusion of red blood cells containing corresponding antigens, thereby avoiding hemolytic transfusion reactions^[12]. Rh blood group incompatibility is the second most common cause of hemolytic disease of the newborn (HDN), with HDN caused by anti-D antibodies typically being more severe, leading to fetal anemia, edema, jaundice, and even stillbirth or neonatal bilirubin encephalopathy^[13–15].

Based on this, this study selected newborns who underwent examinations and were diagnosed with hemolytic disease at our hospital from October 2024 to October 2025 as the research subjects. Through univariate analysis, it was found that IgG1 and IgG3 subclass antibodies, as well as ABO blood group incompatibility, were statistically significant ($p < 0.05$). Subsequently, multivariate logistic regression analysis revealed that IgG1, IgG3, and ABO blood group incompatibility were all positively correlated with neonatal hemolytic disease.

5. Conclusion

In summary, as a significant complication during the perinatal period, hemolytic disease of the newborn (HDN) is closely related to the production of irregular antibodies against maternal red blood cell blood groups. This study systematically analyzed the clinical value of irregular antibody detection in the prevention, diagnosis, and treatment of HDN, revealing the correlation between antibody types, titers, and the severity of HDN, thereby providing a scientific basis for optimizing clinical management strategies. In the future, with advancements in detection technologies and deeper global collaboration, it is essential to reduce the risk of neonatal mortality and long-term neurodevelopmental impairments, safeguarding the health of every newborn.

Disclosure statement

The authors declare no conflict of interest.

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The Application Value of Droplet Digital PCR Technology in the Diagnosis of Bacterial Infections in Febrile Patients

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Abstract: Droplet digital PCR (ddPCR), as the third-generation PCR technology, demonstrates significant advantages in the etiological diagnosis of infectious diseases due to its absolute quantification, ultra-high sensitivity, and multiplex detection capabilities. This article reports a case of a patient with fever of unknown origin, where ddPCR rapidly confirmed a drug-resistant bacterial infection and dynamically monitored treatment efficacy. Combining literature evidence, this paper systematically elaborates on the technical principles, clinical performance, and practical value of ddPCR in febrile patients.

Keywords: Droplet digital PCR; Bacterial infection; Nucleic acid detection; Drug resistance gene

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1. Introduction

Fever poses a significant diagnostic challenge in clinical practice. Traditional methods like blood culture are time-consuming and lack sensitivity, while metagenomic next-generation sequencing (mNGS) is costly and may miss low-biomass infections. Droplet digital PCR (ddPCR), as a third-generation PCR technology, offers absolute quantification and exceptional sensitivity, enabling the detection of rare pathogens. This article reports a case of fever of unknown origin where ddPCR rapidly identified a drug-resistant bacterial infection and guided treatment, highlighting its clinical utility.

2. Case information

The patient, a 78-year-old female, was admitted to the hospital on December 28, 2024, due to “persistent cough and expectoration for over three months, exacerbated by dyspnea for 12 days”.

2.1. Past medical history

She was diagnosed with “gouty arthritis and Alzheimer’s disease” in 2020, suffered a “cerebral infarction” in October 2023, resulting in impaired limb movement, as well as speech and swallowing difficulties; she was diagnosed with “sepsis, severe pneumonia, type II respiratory failure, and severe malnutrition” in January 2024, and the infection was controlled after treatment. Physical examination revealed a temperature of 39.0 °C, blood pressure of 102/56 mmHg (maintained with norepinephrine), indwelling gastric tube and nasotracheal intubation, anemic appearance, coarse breath sounds in both lungs, a small number of crackles in the upper lungs, and a few moist rales in the lower lungs, as well as mild pitting edema in both lower extremities. Blood tests indicated a WBC count of $37.4 \times 10^9/L$, with 84.2% neutrophils, CRP of 183 mg/L, and PCT of 2.5 ng/mL.

2.2. Preliminary examinations

Chest CT showed pneumonia in both lungs, fibrotic lesions in the right upper lung, progression of inflammation in the left lower lobe compared to previous scans, segmental atelectasis in the dorsal and posterior basal segments of the left lower lobe, and bronchial mucus plugging in the left lower lobe; blood culture (negative at 48 hours). Multidrug-resistant *Acinetobacter baumannii* was cultured from bronchoalveolar lavage fluid. Echocardiography revealed mild mitral and tricuspid regurgitation, decreased left ventricular compliance, and left ventricular systolic function below the normal range. Treatment with broad-spectrum antibiotics (piperacillin-tazobactam combined with levofloxacin sodium chloride injection) for 7 days was ineffective.

3. Detection methods

3.1. ddPCR detection process

3.1.1. Sample processing

Collect 5 mL of lung lavage fluid from patients and utilize the fully automated nucleic acid detection reaction system construction system AP10 and the droplet digital PCR system D3207 produced by Pioneer Genomics Technology Co., Ltd. to complete nucleic acid extraction, amplification, and analysis through digital PCR microdroplet chips.

3.1.2. Technical parameters

The amplification time is 0.5 hours, and the lower limit of detection is 1 copy/ μL .

3.2. Comparison with traditional methods

Lung lavage fluid culture and blood culture (using the BACTEC 9120 system).

4. Results

4.1. Etiological diagnosis

4.1.1. Lung lavage fluid ddPCR results

Pseudomonas aeruginosa, 309,315.00 copies/ μL ; *Acinetobacter baumannii*, 21,680.00 copies/ μL ; *Streptococcus* spp., 161,335.00 copies/ μL ; *Stenotrophomonas maltophilia*, > 1,000,000 copies/ μL .

4.1.2. Lung lavage fluid and blood culture

Still remain negative after 72 hours.

4.2. Treatment adjustment and monitoring

Based on the ddPCR results, imipenem/cilastatin (0.5 g q6h) was switched to in combination with tigecycline (initial dose of 100 mg, followed by 50 mg q12h starting from the second dose). On the 7th day of treatment, the body temperature dropped to 37.8 °C. On the 14th day, the body temperature returned to normal, vasoactive drugs were withdrawn, and the patient was weaned off ventilator-assisted breathing. Repeated ddPCR tests showed *Pseudomonas aeruginosa* at 19,940.00 copies/μL, *Acinetobacter baumannii* at 0 copies/μL, *Streptococcus* spp. at 12,790.00 copies/μL, and *Stenotrophomonas maltophilia* at 120,880.00 copies/μL. Imaging revealed scattered pneumonia in both lungs, with fibrotic lesions in the right upper lobe. Repeated examination showed that the inflammation in the left lower lobe had been absorbed compared to before, and the dorsal segment and posterior basal segment of the left lower lobe were no longer present, indicating that the lung tissue had re-expanded.

5. Discussion

Traditional methods for detecting pneumonia pathogens (such as culture and serological testing) have limitations such as time-consuming processes and low sensitivity (approximately 20–30%). Isolating and culturing pathogens requires at least 1 to 3 days to obtain results, with a low detection rate ^[1,2]. ddPCR offers the following three technological advantages: Firstly, ddPCR boasts advantages of ultra-high sensitivity, high specificity, and rapid detection, along with technical characteristics such as high tolerance, absolute quantification, and independence from standard curves. It can reduce the limit of detection to 1 copy/μL, which is a 100-fold improvement over traditional PCR, making it particularly suitable for screening pathogens with low viral loads ^[3,4]. For instance, in the studies conducted by Shen Jiang and Zhao Dongyang, ddPCR was able to detect rare mutations or pathogens with low viral loads as low as 0.001%, achieving a sensitivity of 88.89% and a specificity of 55.61%. It is applicable for detecting latent infections in elderly patients under immunosuppressive conditions, with a reporting time of 3–4 hours, significantly shortening the diagnostic time ^[5]. Secondly, ddPCR enables multi-target joint detection, allowing for the simultaneous detection and accurate identification of multiple pathogens and drug-resistant genes, including 12 types of bacteria and 1 type of fungus, namely *Pseudomonas aeruginosa*, *Escherichia coli*, *Klebsiella pneumoniae*, *Acinetobacter baumannii*, *Staphylococcus aureus*, *Enterococcus* spp., *Candida* spp., *Streptococcus* spp., *Stenotrophomonas maltophilia*, *Enterobacter cloacae*, *Proteus mirabilis*, coagulase-negative staphylococci, and *Serratia marcescens*. The five drug-resistance genes include KPC, mecA, OXA-48, NDM/IMP, and vanA/vanM, covering common drug-resistance genes for three major classes of antibiotics: carbapenems, methicillin, and vancomycin. In contrast, internationally leading technologies such as the BioFire® Pneumonia Panel can simultaneously detect 33 pathogens and drug-resistance genes ^[6]. Thirdly, ddPCR possesses dynamic monitoring capabilities, enabling the construction of a pathogen load-efficacy model through absolute quantification (such as the correlation between a 50% reduction in pathogen load after 72 hours of treatment and 28-day survival rates ^[7]). By integrating artificial intelligence and big data analysis techniques, it can deeply mine vast amounts of pathogenic bacteria genetic data, identify new drug-resistant genes and mutant strains of pathogens, and provide support for precision medicine. The pathogens causing pneumonia in elderly patients are complex, with mixed infections of bacteria (such as *Klebsiella pneumoniae*), viruses (such as influenza viruses),

and fungi being common. The repeated use of multiple antibiotics results in a low detection rate of infections by traditional culture methods, with only 15%. In contrast, ddPCR can simultaneously identify bacteria, fungi, and viruses, increasing the detection rate to over 40%. The detection sensitivity of the digital PCR platform reaches at least 0.1%, enabling precise detection of ultra-trace amounts of pathogens and drug-resistant gene information, thereby improving the detection rate of mixed infections. Research conducted at Nanjing Drum Tower Hospital shows that ddPCR achieves a mixed pathogen detection rate of 23.3% in bloodstream infections, significantly outperforming blood culture (9.1%)^[2]. Based on the advantage of ddPCR technology in detecting drug-resistant genes, it can rapidly screen for the types and load information of drug-resistant genes, guiding early targeted treatment with carbapenems or vancomycin. The team led by Qu Hongping verified that ddPCR can accurately detect the sensitivity and specificity of carbapenem-resistant genes (such as blaKPC and blaNDM) at 84.9% and 92.5%, respectively, and methicillin-resistant genes (mecA), providing results 3–5 days earlier than phenotypic drug susceptibility testing^[8]. Not only blood samples can be used for detection; companies like Linghang Gene Technology are compatible with cerebrospinal fluid, bronchoalveolar lavage fluid, pleural fluid, and ascites, offering operability and accuracy in detecting pathogens in elderly patients with respiratory diseases. Due to prolonged hospitalization and antibiotic exposure, elderly patients have a high infection rate with drug-resistant bacteria, reaching 35–50%. ddPCR completes detection within 3–4 hours, reducing the time by 90% compared to traditional culture methods. Moreover, ddPCR can simultaneously detect carbapenemase genes (such as blaKPC and blaNDM-1) and methicillin-resistant genes (mecA), clarifying the resistance mechanism within 2–3 hours and securing a critical time window for anti-infective treatment. Research at Ruijin Hospital confirmed that for infections caused by *Klebsiella pneumoniae* carrying blaKPC, adjusting the dosage of carbapenems based on ddPCR results increased the treatment effectiveness rate from 52% to 82%, shortened the antibiotic adjustment time to within 6 hours, and reduced mortality by 27%^[9]. Additionally, the multiplex detection kit can cover six common types of drug-resistant genes, including beta-lactams and fluoroquinolones, providing a molecular basis for the selection of narrow-spectrum antibiotics. Leveraging the absolute quantification capability of ddPCR, the overuse of broad-spectrum antibiotics can be avoided, and hospital stays can be shortened. In this case, the treatment cycle was reduced from an estimated 28 days to 14 days, offering a quantitative basis for evaluating treatment efficacy. However, ddPCR also has certain limitations. For instance, the qualification rate of sputum sample collection is only 58%, leading to an increased false-positive rate of nucleic acid detection, which reaches 12%^[10]. The absence of clinical guidelines and recommendations results in variations in the elements and criteria for performance validation among different laboratories, leading to discrepancies in clinical usage outcomes. Therefore, it is necessary to compare the detection results among digital PCR platforms with different liquid dispensing principles. The consistency of detection results between droplet digital PCR methods and traditional detection methods also requires extensive comparative and validation experiments^[11].

6. Conclusion

This case demonstrates that ddPCR offers core advantages of rapidity, precision, and quantifiability in diagnosing bacterial infections in elderly patients with fever, particularly in cases with negative blood cultures or complicated and severe infections. With the promotion of domestic equipment (such as the Xinyi D50, Linghang AD3207, and AD9600) and the advancement of multicenter studies, ddPCR is expected to become a first-line tool for the etiological diagnosis of fever, propelling the field of infectious diseases into the era of precision medicine.

Disclosure statement

The author declares no conflict of interest.

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Evaluation of Nursing Effect and Satisfaction in the Treatment of Pediatric Bronchial Pneumonia with Mechanical Expectorations Drainage Combined with Traditional Chinese Medicine Acupoint Application

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Abstract: *Objective:* To evaluate the nursing value of mechanical expectorations drainage combined with traditional Chinese medicine acupoint application in children with pediatric bronchial pneumonia. *Methods:* A total of 62 children with pediatric bronchial pneumonia treated from May 2024 to May 2025 were selected as samples and randomly divided into groups using a random number table. Group A received mechanical expectorations drainage combined with traditional Chinese medicine acupoint application nursing, while Group B received conventional nursing. Lung function, symptom disappearance time, nursing satisfaction, and inflammatory indicators were compared between the two groups. *Results:* The maximum vital capacity (FVC), forced expiratory volume in one second (FEV), peak expiratory flow (PEF), and maximal mid-expiratory flow (MMEF) in Group A were all higher than those in Group B, with $p < 0.05$; the symptom disappearance time in Group A was shorter than that in Group B, and nursing satisfaction was higher in Group A than in Group B, with $p < 0.05$; the procalcitonin (PCT), white blood cell count (WBC), and serum amyloid A (SAA) levels in Group A were lower than those in Group B, with $p < 0.05$. *Conclusion:* The application of mechanical expectorations drainage combined with traditional Chinese medicine acupoint application nursing in the care of children with pediatric bronchial pneumonia reduces inflammation levels, shortens symptom disappearance time, and improves lung function.

Keywords: Pediatric bronchial pneumonia; Mechanical expectorations drainage; Traditional Chinese medicine acupoint application; Satisfaction

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1. Introduction

Pediatric bronchopneumonia is a common respiratory disease that is associated with respiratory system lesions triggered by viruses, bacteria, and mycoplasma invading the respiratory tract. It can lead to secondary inflammatory responses in organs, exacerbate organ damage, and even endanger the lives of affected children. Common symptoms of pediatric bronchopneumonia include wheezing, coughing up sputum, fever, etc., necessitating timely expectorant, cough-relieving, and anti-infective treatments ^[1]. However, due to the immature development of the airways in children, affected children are unable to expel thick mucus on their own, which can worsen pulmonary dysfunction and even obstruct the respiratory tract, exacerbating dyspnea. Therefore, mechanical vibration sputum evacuation devices should be used to assist in sputum evacuation. On this basis, combined with traditional Chinese medicine acupoint application therapy, which stimulates specific acupoints based on the theory of traditional Chinese medicine meridians, it can enhance the pharmacological effects on tissues and organs with high medication safety ^[2]. This paper explores the nursing value of mechanical sputum evacuation combined with traditional Chinese medicine acupoint application by taking 62 cases of children with pediatric bronchopneumonia who sought medical treatment from May 2024 to May 2025 as samples.

2. Materials and methods

2.1. Materials

Sixty-two children with pediatric bronchopneumonia who sought medical treatment from May 2024 to May 2025 were selected as samples and randomly divided into groups using a random number table. The data of children with pediatric bronchopneumonia in Group A were compared with those in Group B, with $p < 0.05$, as shown in Table 1.

Table 1. Data analysis table for children with pediatric bronchopneumonia

Group	n	Gender (%)		Age (years)		Disease duration (d)	
		Male	Female	Interval	Mean	Interval	Mean
Group A	31	16 (51.61)	15 (48.39)	0.5–12	6.11 ± 0.87	2–7	4.09 ± 0.71
Group B	31	17 (54.84)	14 (45.16)	1–12	6.09 ± 0.91	2–8	4.11 ± 0.68
χ^2/t	-	0.0648		0.0884		0.1133	
p	-	0.7991		0.9298		0.9102	

2.2. Inclusion and exclusion criteria

2.2.1. Inclusion criteria

- (1) Conformity to the criteria for bronchopneumonia outlined in “Zhu Futang’s Practical Pediatrics” ^[3]
- (2) Parental signed informed consent
- (3) Presence of symptoms such as cough, expectoration, fever, etc., along with imaging findings indicative of shadows

2.2.2. Exclusion criteria

- (1) Administration of antibiotics prior to enrollment
- (2) Concomitant severe respiratory diseases

- (3) Age exceeding 14 years

2.3. Treatment methods

2.3.1. Group A

- (1) Mechanical sputum drainage

Prior to sputum drainage, evaluate the pediatric patient to determine the indications for mechanical sputum drainage, and record data such as weight, respiratory status, medication allergies, and underlying diseases. Based on the severity of the pediatric patient's condition, select an appropriate mechanical sputum drainage device to perform vibratory sputum drainage therapy. Adjust the treatment parameters according to the patient's age, body mass, and condition, initially setting the suction frequency to 20 Hz for a duration of 5 minutes, while simultaneously percussing the patient's back to facilitate sputum expulsion. It is recommended to perform vibratory sputum drainage 2–3 times a day, preferably before meals or 2 hours after meals. Prior to vibratory sputum drainage, assist the pediatric patient in maintaining a semi-reclined or upright position, loosen their collar, ensure adequate oral hydration before suctioning, and pay attention to mastering the correct operational techniques during suctioning to avoid causing harm to the patient.

- (2) Traditional Chinese medicine acupoint application, with the following formula

30 g each of asarum and ginger; 15 g each of *Fructus aurantii* and astragalus; 20 g each of mint, platycodon, and perilla leaf. The aforementioned herbs are ground into powder. An appropriate amount of the powder is taken and mixed evenly with vinegar, then evenly applied to the Tiantu acupoint, Feishu acupoint, and Shanzhong acupoint. The medication is fixed with transparent adhesive tape. Each application lasts for 30–60 minutes, 1–2 times per day. Continuous application lasts for 3–7 days.

2.3.2. Group B received routine care

Massage the child's chest to accelerate the discharge of respiratory secretions. Administer antitussive and antipyretic drugs to alleviate symptoms such as fever, cough, and expectoration in the child. Meanwhile, ensure proper nutrition and dietary management to expedite the child's recovery.

2.4. Observation indicators

2.4.1. Pulmonary function indicators

Pulmonary function testers were used to monitor indicators such as FVC, FEV, PEF, and MMEF in the children.

Time of symptom disappearance and nursing satisfaction: Record the time for the child's body temperature to return to normal, the time for lung sounds to disappear, and the time for cough to subside; evaluate using our self-made pediatric bronchial pneumonia nursing satisfaction scale, with scores of 30–100 indicating satisfaction and scores < 30 indicating dissatisfaction.

2.4.2. Inflammatory indicators

Collect 5 mL of venous blood from the child, centrifuge (for 10 minutes at a speed of 3500 r/min) to obtain serum, and detect PCT and SAA using the enzyme-linked immunosorbent assay method; detect WBC using a blood cell analyzer.

2.5. Statistical study

Data were processed using SPSS 23.0, with the chi-square test used for count data and recorded as percentages, and the *t*-test used for measurement data and recorded as mean \pm standard deviation ($\bar{x} \pm s$). Statistical differences were considered significant at $p < 0.05$.

3. Results

3.1. Pulmonary function indicators

After nursing, the FEV1, MMEF, FVC, and PEF in Group A were all higher than those in Group B, with $p < 0.05$. See **Table 2**.

Table 2. Analysis of pulmonary function indicators ($\bar{x} \pm s$)

Group	FEV1 (L)		MMEF (L/S)		FVC (L)		PEF (L/S)	
	Before	After	Before	After	Before	After	Before	After
Group A (n = 31)	2.05 \pm 0.18	2.74 \pm 0.26	0.89 \pm 0.35	1.68 \pm 0.51	1.59 \pm 0.32	2.56 \pm 0.49	2.79 \pm 0.42	4.43 \pm 0.59
Group B (n = 31)	2.07 \pm 0.21	2.49 \pm 0.24	0.91 \pm 0.33	1.41 \pm 0.43	1.58 \pm 0.36	2.12 \pm 0.41	2.81 \pm 0.46	4.02 \pm 0.51
<i>t</i>	0.4026	3.9339	0.2315	2.2535	0.1156	3.8344	0.1788	2.9271
<i>p</i>	0.6887	0.0002	0.8177	0.0279	0.9084	0.0003	0.8587	0.0048

3.2. Time of symptom disappearance and nursing satisfaction

The time for symptom disappearance in Group A was shorter than that in Group B, and the nursing satisfaction in Group A was higher than that in Group B, with $p < 0.05$. See **Table 3**.

Table 3. Analysis table of time of symptom disappearance and nursing satisfaction ($\bar{x} \pm s$)

Group	Time to temperature normalization (d)	Time to lung sound disappearance (d)	Time to cough disappearance (d)	Nursing satisfaction [n(%)]
Group A (n = 31)	2.81 \pm 0.21	4.71 \pm 0.32	4.61 \pm 0.42	30 (96.77)
Group B (n = 31)	3.09 \pm 0.33	5.21 \pm 0.43	5.42 \pm 0.55	25 (80.65)
Statistical value (<i>t</i> / χ^2)	3.9856	5.1938	6.5169	4.0260
<i>p</i> -value	0.0002	0.0000	0.0000	0.0448

3.3. Inflammatory factor indicators

After nursing care, the levels of PCT, WBC, and SAA in Group A were lower than those in Group B, with $p < 0.05$. See **Table 4**.

Table 4. Analysis table of inflammatory factor indicators ($\bar{x} \pm s$)

Group	PCT (ng/mL)		WBC (X109/L)		SAA (μg/mL)	
	Before	After	Before	After	Before	After
Group A (n = 31)	1.88 ± 0.25	1.02 ± 0.11	19.62 ± 0.72	9.79 ± 0.62	235.25 ± 6.29	68.44 ± 2.43
Group B (n = 31)	1.85 ± 0.28	1.29 ± 0.19	19.58 ± 0.74	11.42 ± 0.68	235.79 ± 6.31	73.59 ± 4.11
<i>t</i>	0.4450	6.8473	0.2157	9.8623	0.3375	6.0055
<i>p</i>	0.6579	0.0000	0.8299	0.0000	0.7370	0.0000

4. Discussion

Bronchopneumonia is associated with inflammation induced by lower respiratory tract infections. Affected by the deficiency of Yin Qi in children, after the invasion of cold, heat, and pathogenic factors, the lung heat in the body burns Yin fluid and accumulates phlegm, which can block the lung collaterals and cause the upward reversal of lung Qi, manifesting as shortness of breath, chest tightness, and cough. It should be treated with prescriptions that promote blood circulation to remove blood stasis and unblock collaterals, as well as clear and descend lung Qi, in order to prevent pathogenic factors from invading the jueyin meridian^[4]. Acupoint application conforms to the traditional Chinese medicine concept of treating internal diseases with external methods, which can avoid gastrointestinal reactions and liver damage associated with oral medications. Moreover, the application of drugs through specific acupoint skin penetration can achieve multiple effects such as descending Qi, relieving asthma, and expelling phlegm^[5,6]. In addition, traditional Chinese medicine acupoint application therapy allows drugs to permeate through the body surface and be directly absorbed through the skin, enabling the active pharmaceutical ingredients to reach the internal organs directly. This therapy can expel pathogenic factors, stimulate the functions of meridians and internal organs, and collectively achieve the effects of eliminating evil and strengthening the body as well as regulating Yin and Yang^[7,8]. Based on this, combined with mechanical sputum drainage nursing, which vibrates the mucus in the deep fine bronchi, it can accelerate the discharge of sputum and help alleviate discomfort in pediatric patients.

Based on the data analysis in this article, after mechanical sputum drainage combined with traditional Chinese medicine acupoint application nursing, indicators such as FEV1, MMEF, FVC, and PEF improved. Analyzing the reasons, mechanical sputum drainage loosens airway mucus, reducing airflow resistance and improving airway patency. When combined with traditional Chinese medicine application, ingredients like asarum and ginger stimulate the relaxation of bronchial smooth muscle, relieving mucosal congestion and edema. Moreover, applying the patches to acupoints such as Danzhong (CV17) and Feishu (BL13) helps disperse and regulate lung Qi, thereby increasing the FEV1 level. The vibrating effect of mechanical sputum drainage reaches the peripheral airways directly, relieving the obstruction caused by secretions in the airways and optimizing airway ventilation function. When combined with traditional Chinese medicine application, ingredients like mint and perilla leaf soothe the throat and clear heat, reducing mucosal swelling and thus increasing the MMEF level. Mechanical sputum drainage accelerates the discharge of residual air and sputum retained in the airways, promoting lung expansion and increasing the effective ventilation volume of the lungs. When combined with traditional Chinese medicine application, astragalus ingredients can stabilize the exterior and replenish Qi, enhancing respiratory muscle

strength and increasing vital capacity, thereby increasing the FVC level ^[9,10]. In addition, mechanical expectoration can rapidly remove sputum from the proximal airways, reducing the instantaneous resistance to airflow expulsion and increasing peak expiratory flow rate. When combined with traditional Chinese medicine (TCM) patches containing ingredients such as ginger and asarone, which warm and invigorate Yang, bronchial spasms can be alleviated, leading to an elevation in PEF levels ^[11]. Another set of data indicates that after mechanical expectoration combined with TCM acupoint application nursing, the time for symptom disappearance in patients is shortened, and nursing satisfaction improves. Analyzing the reasons, mechanical expectoration accelerates the excretion of inflammatory factors in the respiratory system, reducing the stimulation of the thermoregulatory center by inflammation. Moreover, TCM ingredients such as asarone and ginger can dispel cold and expel pathogenic factors, while mint can relieve the exterior and clear heat, all of which can accelerate the recovery of body temperature in children. Mechanical expectoration rapidly clears respiratory secretions and sputum, relieving airway narrowing in children and accelerating the disappearance of pulmonary rales. TCM ingredients such as perilla leaf and platycodon can relieve cough and expectorate phlegm, and applying patches at the Feishu acupoint can regulate lung Qi and promote the absorption of inflammatory exudates in the lungs, helping to reduce airway edema and accelerate the disappearance of pulmonary sounds. Furthermore, mechanical expectoration can reduce the adverse stimulation of inflammatory secretions and sputum on the airway mucosa, lowering the frequency of cough reflex. Combined with TCM patch treatment, it can inhibit the cough reflex and reduce the severity of cough ^[12]. In addition, combined therapy rapidly improves airway ventilation function, alleviates uncomfortable symptoms such as dyspnea and hypoxia, and the application of traditional Chinese medicine (TCM) plaster can exert effects such as expectorating phlegm, anti-inflammation, and enhancing immunity, which is conducive to preventing the recurrence of symptoms in children with pneumonia, thereby resulting in higher satisfaction among the families of the children ^[13]. The last set of data indicates that after mechanical sputum elimination combined with TCM acupoint application nursing, the levels of inflammatory factors in children decrease. Analyzing the reasons, mechanical sputum elimination rapidly clears secretions related to airway infection foci and inhibits the colonization of pathogens in the body, thereby reducing the release of procalcitonin (PCT) and the synthesis of serum amyloid A (SAA). Moreover, when combined with TCM plaster therapy, the combined use of various Chinese herbal medicines exerts antibacterial and anti-inflammatory effects, inhibits inflammatory signaling pathways, and further reduces the levels of inflammatory factors in children ^[14]. Additionally, mechanical sputum elimination clears inflammatory necrotic tissues and pathogens from the airways, reducing the aggregation of white blood cells at inflammatory sites. When combined with TCM plaster therapy, *Astragalus membranaceus* can regulate immune system function and inhibit abnormal increases in white blood cells caused by excessive immune activation, facilitating the restoration of normal white blood cell (WBC) levels ^[15].

5. Conclusion

In summary, mechanical sputum elimination combined with TCM acupoint application nursing for children with pediatric bronchopneumonia can enhance parental satisfaction, reduce the levels of inflammatory factors in children, shorten the duration of symptoms, and improve lung function in children, demonstrating its value for widespread adoption.

Disclosure statement

The authors declare no conflict of interest.

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Analysis of the Sleep Regulation Effects of Herbal Sleep-Aiding Pillows in Treating Insomnia Due to Gallbladder Deficiency

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Abstract: *Objective:* To analyze the value of herbal sleep-aiding pillows in regulating sleep quality in patients with insomnia due to gallbladder deficiency. *Methods:* Eighty patients with insomnia due to gallbladder deficiency were treated from April 2023 to April 2024 and were randomly divided into groups by drawing lots. Group A used herbal sleep-aiding pillows, while Group B received Western medication. *Results:* The therapeutic efficacy, HAMA scores, HAMD scores, PSQI scores, and symptom scores of patients in Group A were all superior to those in Group B, with $p < 0.05$. *Conclusion:* Treatment with herbal sleep-aiding pillows for insomnia due to gallbladder deficiency resulted in decreased emotional scores, improved sleep quality, and reduced insomnia symptom scores, which is beneficial for the prognosis of patients with insomnia.

Keywords: Herbal sleep-aiding pillow; Insomnia due to gallbladder deficiency; Sleep regulation

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1. Introduction

Insomnia refers to a category of diseases where individuals, despite being in a suitable sleeping environment, are still unable to enter deep sleep or are dissatisfied with their sleep duration. This condition may adversely affect patients' daytime social functioning and even impact their subjective experience. Insomnia can be triggered by numerous factors, including diseases, physiological conditions, mental states, environmental factors, and medications, with psychological and mental factors playing a significant role^[1]. Prolonged insomnia in patients can lead to endocrine disorders, circadian rhythm imbalances, and over time, impair the body's immunity, affect cranial thinking, accelerate aging, and even induce various comorbidities. Western medicine often treats insomnia with medications, but these treatments have limitations due to issues such as addiction and muscle relaxation. Traditional Chinese medicine scholars categorize insomnia under the scope of "sleeplessness" based on symptoms and have demonstrated excellent efficacy in regulating insomnia through external treatments, such as herbal sleep-aiding pillows. This study explores the sleep-regulating effects of herbal sleep-aiding pillows using a sample of 80

patients with insomnia due to gallbladder deficiency.

2. Materials and methods

2.1. Materials

Eighty patients with insomnia due to gallbladder deficiency were treated from April 2023 to April 2024 and were randomly divided into groups by drawing lots. The baseline data for insomnia in Group A were compared with those in Group B, with $p > 0.05$. See **Table 1**.

Table 1. Baseline data analysis table for patients with insomnia due to gallbladder deficiency

Group	n	Gender		Age (years)		Disease duration (months)	
		Male	Female	Range	Mean \pm SD	Range	Mean \pm SD
A	40	21 (52.50)	19 (47.50)	26–61	50.19 \pm 1.81	3–42	17.68 \pm 1.27
B	40	22 (55.00)	18 (45.00)	26–62	50.21 \pm 1.78	3–41	17.72 \pm 1.29
Statistic (χ^2/t)		0.0503			0.0498		0.1397
p -value		0.8226			0.9604		0.8892

2.2. Inclusion and exclusion criteria

2.2.1. Inclusion criteria

- (1) Experiencing symptoms such as difficulty falling asleep, early awakening, difficulty maintaining sleep, and low sleep quality
- (2) Signing the informed consent form
- (3) The aforementioned symptoms persist for 3 months, with insomnia occurring at least 3 times per week

2.2.2. Exclusion criteria

- (1) Allergy to traditional Chinese medicine
- (2) Severe physical illnesses
- (3) Sleep disorders induced by external environmental factors, diseases, alcohol, medications, or other causes

2.3. Treatment methods

Group A received treatment with a herbal sleep-aid pillow, with the following formula: *Caulis polygoni multiflori*, Silkworm Excrement, and *Concha margaritifera usta*, each 30 g; *Forsythiae fructus* and *Rhizoma Acori Tatarinowii*, each 20 g; *Cassiae semen*, *Radix Acanthopanax Senticosus*, *Radix Polygalae*, and *Radix Curcumae*, each 15 g; *Flos Rosae rugosae* 12 g; *Flos Mume* and *Flos Chrysanthemi*, each 10 g; *Radix Bupleuri* 9 g; and *Herba Menthae* 6 g. The aforementioned herbs were made into a pillow core and placed inside the patient's pillow. Patients were required to lie on the herbal pillow every night at 21:00 until 7:00 the next morning. The herbal pillow was to be placed in a cool, ventilated area during the remaining time to maintain its dryness and avoid odors and insect infestation. The herbal pillow was replaced once a week, and the treatment was administered for 8 weeks.

Group B received oral estazolam at a single dose of 2 mg, once daily, for 8 weeks.

2.4. Statistical study

Statistical analysis was performed using SPSS 22.0 software. General data and scale scores were expressed as mean \pm standard deviation. The *t*-test was used for inter-group and pre-post comparisons of intervention effects. A *p*-value of less than 0.05 was considered statistically significant.

3. Results

3.1. Efficacy

The efficacy rate in Group A for patients with timidity-induced insomnia was 97.50%, which was higher than that in Group B at 82.50%, with *p* < 0.05. As shown in **Table 2**.

Table 2. Efficacy analysis table for patients with timidity-induced insomnia (n, %)

Group	Markedly effective	Effective	Ineffective	Effective rate
Group A (n = 40)	28 (70.00)	11 (27.50)	1 (2.50)	39 (97.50)
Group B (n = 40)	20 (50.00)	13 (32.50)	7 (17.50)	33 (82.50)
χ^2 -value				5.0000
<i>p</i> -value				0.0253

3.2. Negative emotions

After 8 weeks of medication, patients with timidity-induced insomnia in Group A had lower HAMA and HAMD scores compared to Group B, with *p* < 0.05. As shown in **Table 3**.

Table 3. Negative emotion analysis table for patients with timidity-induced insomnia ($\bar{x} \pm s$)

Group	HAMA score (points)		HAMD score (points)	
	Before medication	Week 8	Before medication	Week 8
Group A (n = 40)	16.81 \pm 2.14	5.72 \pm 1.02	15.36 \pm 1.89	5.19 \pm 1.01
Group B (n = 40)	16.79 \pm 2.19	7.09 \pm 1.14	15.33 \pm 1.91	7.11 \pm 1.17
<i>t</i> -value	0.0413	5.6643	0.0706	7.8564
<i>p</i> -value	0.9672	0.0000	0.9439	0.0000

3.3. Sleep quality

After 2, 3, and 4 weeks of medication, the PSQI scores of patients with timidity-induced insomnia in Group A were lower than those in Group B, with *p* < 0.05. As shown in **Table 4**.

Table 4. Sleep quality score analysis table for patients with timidity-induced insomnia ($\bar{x} \pm s$)

Group	Before treatment	Week 2 of treatment	Week 3 of treatment	Week 4 of treatment
Group A (n = 40)	17.33 \pm 1.51	11.28 \pm 1.24	9.48 \pm 0.89	8.41 \pm 0.72
Group B (n = 40)	17.42 \pm 1.48	14.21 \pm 1.33	12.44 \pm 0.96	10.86 \pm 0.91
<i>t</i> -value	0.2692	10.1909	14.3006	13.3534
<i>p</i> -value	0.7885	0.0000	0.0000	0.0000

3.4. Symptom score

After 8 weeks of medication, the symptom scores of patients with timidity-induced insomnia in Group A were all lower than those in Group B, with $p < 0.05$, as shown in **Table 5**.

Table 5. Analysis table of symptom scores for patients with timidity-induced insomnia ($\bar{x} \pm s$)

Group	Difficulty falling asleep		Dream-disturbed sleep		Restlessness		Mental fatigue	
	Before Treatment	After Treatment	Before Treatment	After Treatment	Before Treatment	After Treatment	Before Treatment	After Treatment
Group A (n = 40)	2.41 ± 0.35	0.61 ± 0.28	2.43 ± 0.38	0.59 ± 0.25	2.42 ± 0.36	0.61 ± 0.21	2.45 ± 0.37	0.59 ± 0.23
Group B (n = 40)	2.42 ± 0.36	1.33 ± 0.31	2.45 ± 0.39	1.36 ± 0.31	2.44 ± 0.38	1.28 ± 0.32	2.46 ± 0.38	1.31 ± 0.33
<i>t</i> -value	0.1260	10.9010	0.2323	12.2284	0.2416	11.0710	0.1192	11.3207
<i>p</i> -value	0.9001	0.0000	0.8169	0.0000	0.8097	0.0000	0.9054	0.0000

4. Discussion

Patients with insomnia often experience symptoms such as difficulty falling asleep, early awakening, frequent awakenings, and vivid dreaming. Long-term insomnia leads to insufficient sleep efficiency, failing to meet patients' daily needs, and can result in secondary daytime dysfunction. Based on modern medical theory, the pathogenesis of insomnia is complex and closely related to various factors such as endocrine dysfunction, poor environment, genetics, and high psychological stress^[2]. Currently, Western medicine primarily treats insomnia with estazolam, which has a rapid onset of action but is associated with issues such as drug resistance and dependence. Long-term use can impair patients' cognitive function, increase the risk of daytime sleepiness, and reduce drug efficacy over time^[3].

Traditional Chinese medicine scholars categorize insomnia under the term “insomnia disorder” and believe that its pathogenesis involves Yin-Yang disharmony and dysfunction of the internal organs, leading to disharmony between the nutrient and defensive aspects of Qi over time. A common syndrome type is “timidity-induced insomnia,” which is related to the heart being undernourished due to weakness of gallbladder Qi, and can induce symptoms such as sleeplessness, vexation, restlessness, and palpitations. This paper selects herbal sleep-aid medicinal pillows for the treatment of patients with insomnia, which can effectively improve their sleep quality. Through the synergistic effects of acupoint stimulation, transdermal absorption, aromatic volatilization, and various other pathways, highly efficient improvement in insomnia can be achieved. The herbal sleep-aid medicinal pillow in this paper incorporates multiple Chinese herbal medicines, which collectively work to calm the mind, nourish the heart, promote bile flow, soothe the liver, open the orifices, emit fragrance, remove blood stasis, and clear heat.

Based on pharmacological analysis of traditional Chinese medicine, the herbs in the herbal sleep-aid medicinal pillow complement each other. Mint can dispel wind-heat and clear the head and eyes; chrysanthemum can detoxify, clear heat, improve eyesight, and soothe the liver; *Caulis polygoni multiflori* can nourish the liver and kidneys, calm the mind, and nourish the heart; *Acanthopanax senticosus* can calm the mind, nourish the kidneys, invigorate the spleen, and replenish Qi; *Acorus tatarinowii* can calm the heart and mind, open the orifices, and remove dampness; cassia seeds can improve eyesight, regulate emotions, promote bowel movements, and

moisten the intestines; white bupleurum can elevate yang, relieve depression, and soothe the liver; polygala can nourish the heart, enhance intelligence, and calm the mind; silkworm excrement can resolve turbidity, harmonize the stomach, and dispel wind-dampness; mother-of-pearl can calm the mind, sedate, soothe the liver, and subdue yang; forsythia can reduce swelling, disperse nodules, detoxify, and clear heat; turmeric tuber can clear the heart, relieve depression, promote the circulation of Qi, and activate blood; rose can relieve depression, soothe the liver, harmonize blood, and promote the circulation of Qi; plum blossom can disperse nodules, eliminate phlegm, harmonize the middle, and soothe the liver. The combined use of various formulas in herbal sleep-aid pillows can work together to regulate Qi movement and disperse gallbladder stagnation, thereby helping to stabilize the spirit and soul of patients suffering from insomnia due to gallbladder deficiency.

Based on modern pharmacological analysis, herbal sleep-aid pillows offer holistic regulation and multi-target effects. For instance, the menthol component in mint can provide local anesthesia and sedation; the flavonoids in chrysanthemum can regulate neurotransmitters, while also exhibiting antioxidant and anti-inflammatory properties; the phospholipids and anthraquinones in fleecflower stem can enhance memory and improve sleep quality in patients; saponins and *acanthopanax senticosus* can alleviate the body's stress response and achieve adaptive restoration; the volatile oil β -asarone in sweet flag can prevent convulsions and provide sedation; the chrysophanol in cassia seed can promote bowel movements and laxation, as well as prevent gastrointestinal heat accumulation; the saponins in *Bupleurum* and *Polygala* can regulate the HPA axis, reduce depression and anxiety, stimulate the expression of nerve growth factors, and optimize cognitive function in patients; the amino acids and chlorophyll in silkworm excrement can protect nerve function; mother-of-pearl is rich in amino acids and calcium carbonate, which can block the central nervous system; the curcumin in turmeric and forsythiaside in *Forsythia* are rich in components that can protect nervous system function, providing antibacterial and anti-inflammatory effects; the aromatic alcohols and volatile oils in plum blossom and rose can regulate the olfactory nerve, helping to relieve patient anxiety and improve sleep quality. The synergistic effects of the aforementioned herbs can accelerate local skin and respiratory absorption, facilitating the regulation of neurotransmitter levels related to sleep, including GABA and 5-HT^[4].

Based on the data analysis in this article, patients with insomnia due to gallbladder deficiency exhibited excellent therapeutic outcomes after treatment with herbal sleep-promoting pillows. The reason for this is that these pillows can achieve a "holistic treatment" effect, aligning with the modern pathogenesis of "gallbladder deficiency and liver stagnation" in insomnia patients. When using herbal sleep-promoting pillows to treat insomnia, the combination of *Polygonum multiflorum* and *Acanthopanax senticosus* can calm the mind, nourish the heart, strengthen the spleen, and replenish Qi, optimizing the body's microcirculation and replenishing energy. This can alleviate symptoms such as fatigue and mental exhaustion, thereby compensating for the lack of overall tonic effects in Western medicine.

Another set of data indicates that after treatment with herbal sleep-promoting pillows, HAMA and HAMD scores decreased in patients with insomnia due to gallbladder deficiency. The reason for this is that chrysanthemum, plum blossom, and rose contain abundant volatile aromatic oils. When placed in a medicinal pillow and inhaled through the nose, these oils can exert pharmacological effects on systems such as the hypothalamus, hippocampus, and amygdala, enhancing patients' memory abilities and stabilizing their emotions. Furthermore, aromatic molecules can regulate the release of neurotransmitters such as DA and 5-HT in the body, enhancing antidepressant and anxiolytic effects, thus leading to a decrease in HAMA and HAMD scores^[5]. Another set of data indicates that after treatment with herbal sleep-aid pillows, the PSQI scores of patients with

insomnia due to timidity of the gallbladder decreased.

Analyzing the reasons, the treatment with herbal sleep-aid pillows regulates patients' sleep quality through multiple targets, shortens their sleep latency, which is related to the ability of drugs such as chrysanthemum and mint to clear the head and eyes, calm the liver, and clear heat, reducing patients' irritability and optimizing their sleep quality. Meanwhile, mother-of-pearl can calm the mind and suppress, blocking central nervous system excitation and accelerating patients' entry into deep sleep states; it can also inhibit sleep disorders and optimize nighttime sleep efficiency, which is related to the ability of drugs such as *Acanthopanax senticosus* and *Caulis polygoni multiflori* to tonify the kidneys, enhance intelligence, and calm the mind. Moreover, active ingredients such as acanthopanax glycosides and anthraquinone glycosides can exert a mild regulatory effect on the GABAergic system, thereby prolonging patients' deep sleep duration and improving sleep structure, which is beneficial for alleviating symptoms such as easy awakening and dreaminess; it can also reduce the degree of daytime dysfunction. For example, the medicinal components of *Acanthopanax senticosus* can enhance the body's resistance to fatigue, while the medicinal components of *Caulis polygoni multiflori* can regulate Qi and blood, alleviating symptoms of fatigue and weakness caused by restless sleep, which is conducive to establishing a healthy sleep-wake cycle ^[6]. The last set of data indicates that after treatment with herbal sleep-aid pillows, the symptom scores of patients with insomnia due to gallbladder deficiency decreased across all categories. Herbal sleep-aid pillows can provide targeted conditioning for symptoms of insomnia due to gallbladder deficiency. For instance, herbs such as mint and conch shell are used to alleviate the symptom of "difficulty falling asleep," exerting effects such as clearing the head and eyes and soothing the liver. Herbs like *Acorus gramineus* and *Polygala tenuifolia* are employed to regulate the symptom of "excessive dreaming," delivering sedative and tranquilizing effects. Cassia seed, chrysanthemum, and forsythia are utilized to address the symptom of "restlessness and unease," exhibiting effects such as cooling the blood, clearing the heart, relieving depression, and promoting the flow of Qi. *Polygonum multiflorum* stem and *Eleutherococcus senticosus* are used to modulate the symptom of "mental and physical fatigue," providing sedative, kidney-tonifying, spleen-strengthening, and Qi-invigorating effects ^[7].

5. Conclusion

In summary, patients with insomnia due to gallbladder deficiency who received treatment with herbal sleep-aid pillows experienced a decrease in symptom scores, improved sleep quality, and reduced anxiety and depression, demonstrating its potential for widespread application.

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Application of 3D Printing Technology in Oral Implant Dentistry and Its Impact on Bite Force and Masticatory Efficiency

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Abstract: *Objective:* To analyze the impact of 3D printing technology application on bite force and masticatory efficiency in patients following oral implant dentistry treatment. *Methods:* A total of 84 patients with single-tooth defects, selected from 100 patients who sought treatment from May 2023 to March 2025 and met the study criteria, were included in this study. The patients were divided into groups using a random number table method. The control group (42 cases) received conventional oral implant treatment, while the observation group (42 cases) underwent oral implant treatment guided by 3D printing technology. Both groups were followed up continuously for 6 months postoperatively. Masticatory efficiency, bite force, implantation accuracy indicators, and the incidence of treatment complications were compared between the two groups before treatment and 6 months after treatment. *Results:* There was no statistically significant difference in the incidence of complications following oral implantation between the two groups ($p > 0.05$). Compared to the control group, the observation group showed increased masticatory efficiency and bite force after oral implant treatment, with statistically significant differences in the deviation values of the implant crown, apical part in the sagittal plane, axial angle, and neck ($p < 0.05$). *Conclusion:* The application of 3D printing technology in oral implant treatment can effectively reduce implant placement deviations, enhance implantation accuracy, and effectively correct and maintain the oral occlusal force and masticatory function health of patients.

Keywords: Oral implant; 3D printing technology; Occlusal force; Masticatory efficiency

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1. Introduction

Oral implant treatment, as the primary restorative treatment for patients with dentition defects at this stage, involves implanting implants into the areas of dentition loss in the patient's mouth. After completing the second-stage crown restoration, it actively restores the patient's dentition health and offers clear fixed support and aesthetic advantages^[1]. Traditional oral implant treatment operations rely on two-dimensional preoperative oral imaging for treatment assessment, providing guidance for oral implant treatment by analyzing characteristics

such as the thickness of the alveolar bone and anatomical structures at the implantation site. However, due to limitations in imaging observation angles, inadequate precision in implant placement can lead to adverse outcomes such as infection and long-term implant loosening, affecting the correction of oral masticatory function and occlusal force in patients, thus presenting application limitations ^[2,3]. As a novel technology widely applied in orthopedic surgical treatment in recent years, 3D printing technology can utilize the three-dimensional imaging examination results of the bone structure at the surgical site before the operation to print a 3D model. Subsequently, by simulating therapeutic procedures, it provides more precise and effective operational guidance for the actual treatment of patients. Alternatively, this technology can be applied to oral implant therapy to optimize actual therapeutic outcomes ^[4]. Therefore, to analyze the impact of the application of 3D printing technology on the bite force and masticatory efficiency of patients after oral implant treatment, a study was specifically conducted, with details as follows.

2. Materials and methods

2.1. Clinical data

Eighty-four patients meeting the study criteria were selected from 100 patients with single-tooth defects who sought treatment from May 2023 to March 2025 as the research subjects for the therapeutic study. They were divided into a control group and an observation group using the random number table method, with 42 patients in each group. There were no statistically significant differences in age, location of tooth defects, or causes between the two groups ($p > 0.05$), as detailed in **Table 1**.

Table 1. Comparison of clinical data between the two groups

Clinical data		Control group (n = 42)	Observation group (n = 42)	Statistical value (χ^2/t)	p-value
Gender (n, %)	Male	24 (57.14)	22 (52.38)	0.192	0.661
	Female	18 (42.86)	20 (47.62)		
Age (years, Mean \pm SD)		55.68 \pm 6.32	55.71 \pm 6.45	0.022	0.983
BMI (kg/m ² , Mean \pm SD)		21.45 \pm 0.62	21.49 \pm 0.65	0.289	0.774
Missing tooth position (n, %)	Anterior	9 (21.43)	11 (26.19)	0.263	0.608
	Posterior				
Etiology of tooth loss (n, %)	Trauma	14 (33.33)	12 (28.57)	0.369	0.712
	Periodontal disease	23 (54.76)	25 (59.52)		
	Other	5 (11.90)	5 (11.90)		

2.1.1. Inclusion criteria

- (1) Meeting the diagnostic criteria for single tooth dentition defect
- (2) Sufficient bone mass at the fractured defect site, with an intermaxillary distance ≥ 10 mm
- (3) Meeting the indications for oral implant treatment
- (4) No abnormal oral occlusion

2.1.2. Exclusion criteria

- (1) Adjacent teeth in the implant area with lesions or severe periodontal disease

- (2) Presence of severe bone metabolic disorders
- (3) Contraindications to oral implant treatment
- (4) Pregnant or lactating women
- (5) Incomplete clinical follow up information

2.2. Methods

2.2.1. Control group (Conventional oral implant treatment)

Preoperative oral CT scan examination was performed to analyze the occlusal health and anatomical relationships at the dentition defect site. Subsequently, a silicone rubber impression was taken, and a transparent resin film implant guide was fabricated using a vacuum press machine to locate the implant insertion points. After completing the above treatment preparations, the patient was scheduled to receive oral implant treatment. Prior to oral implantation, local infiltration anesthesia was administered to the periodontal tissues at the implant site. After anesthesia, disinfection and draping were performed. Following incision of the gingiva along the top of the alveolar ridge at the implant site, the subgingival tissues were separated to expose the alveolar bone. Subsequently, drilling and rinsing of the alveolar bone implant holes were completed, followed by implant placement. After fixation, the gingiva was sutured. Postoperatively, routine anti-infective and oral hygiene treatments were administered as needed, and secondary crown restoration treatment was completed as required.

2.2.2. Observation group (Oral implant treatment guided by 3D printing)

Before surgery, oral CT and 3D scanning examinations were performed as needed. Three-dimensional imaging data was utilized to reconstruct oral three-dimensional images, and a comprehensive analysis was conducted on the occlusal health and anatomical relationships following dentition defects. Individualized implant guides and surgical plans were designed, and the implantation of dental implants was simulated through virtual surgery to achieve the optimal implantation effect. After completing the above preparations, an implant guide was fabricated using a 3D printer. The implant was then placed using the guide, with the implantation procedure and postoperative treatment being the same as those in the control group.

2.3. Observation indicators

2.3.1. Masticatory efficiency

A peanut (2 g) masticatory test was conducted. The weight of peanut residue after 20 chews on each side of the teeth was measured to calculate the masticatory efficiency.

2.3.2. Bite force

A test piece was placed at the position of the mandibular first premolar. Subjects were instructed to bite evenly for 20 seconds, and the test was repeated 10 times consecutively. The mean value of the three strongest bite force test results was taken as the final test data.

2.3.3. Implantation accuracy indicator

Six months after dental implant placement, oral CT images were reviewed. After three-dimensional image reconstruction, the actual apical implantation positions, axial angles, and cervical deviations in the sagittal and coronal planes under the maximum axial section of the implant guide design and the implant were measured.

2.3.4. Incidence of treatment complications

The overall incidence of complications within six months after implant placement was recorded, including three categories: infection, tooth pain, and implant loosening.

2.4. Statistical methods

Data were analyzed using SPSS 24.0 software. Normally distributed continuous data were expressed as ($\bar{x} \pm s$) and compared using t-tests. Categorical data were expressed as n (%) and compared using appropriate statistical tests. A statistically significant difference was considered when $p < 0.05$.

3. Results

3.1. Comparison of chewing efficiency and bite force between the two groups

Before and after treatment before treatment, there was no statistically significant difference in chewing efficiency and bite force between the two groups ($p > 0.05$). After treatment, both chewing efficiency and bite force increased in patients, with the observation group showing higher values than the control group, and the differences were statistically significant ($p < 0.05$). See **Table 2**.

Table 2. Comparison of chewing efficiency and bite force between the two groups before and after treatment ($\bar{x} \pm s$)

Group	Masticatory efficiency (%)		Bite force (kg)	
	Before treatment	After treatment	Before treatment	After treatment
Control group (n = 42)	55.65 \pm 5.58	75.36 \pm 6.85*	39.24 \pm 5.32	52.36 \pm 6.31*
Observation group (n = 42)	55.74 \pm 5.49	82.95 \pm 7.81*	39.32 \pm 5.25	58.25 \pm 6.74*
t-value	0.075	4.735	0.069	4.134
p-value	0.941	< 0.001	0.945	< 0.001

Note: Compared with the same group before treatment, * $p < 0.05$.

3.2. Comparison of implantation accuracy indicators between the two groups

In the observation group, the deviation values of the implant crown, apical part in the sagittal plane, axial angle, and neck after oral implantation were all lower than those in the control group, with statistically significant differences ($p < 0.05$). See **Table 3**.

Table 3. Comparison of implantation accuracy indicators between the two groups ($\bar{x} \pm s$)

Group	Coronal plane			Sagittal plane		
	Apex (mm)	Axial angle (°)	Neck (mm)	Apex (mm)	Axial angle (°)	Neck (mm)
Control group (n = 42)	0.93 \pm 0.15	3.28 \pm 0.35	0.75 \pm 0.13	0.82 \pm 0.12	2.58 \pm 0.41	0.48 \pm 0.08
Observation group (n = 42)	0.55 \pm 0.07	1.65 \pm 0.11	0.40 \pm 0.05	0.42 \pm 0.05	1.45 \pm 0.22	0.28 \pm 0.03
t-value	14.878	28.793	16.285	19.941	15.739	15.170
p-value	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001

3.3. Comparison of incidence rates of treatment complications between the two groups

There was no statistically significant difference in the incidence rates of treatment complications between the two groups ($p > 0.05$). See **Table 4**.

Table 4. Comparison of incidence rates of treatment complications between the two groups (n, %)

Group	Infection	Tooth pain	Implant loosening	Total incidence
Control group (n = 42)	2 (4.76)	1 (2.38)	1 (2.38)	4 (9.52)
Observation group (n = 42)	1 (2.38)	0	0	1 (2.38)
χ^2 -value				1.914
p -value				0.167

4. Discussion

Dentition defects, as a common type of oral disease, are primarily induced by local tooth loss due to trauma or periodontal diseases. They can affect the oral functional health of patients due to the loss of one or multiple teeth, manifesting mainly as abnormalities in biting force and chewing function, and also impacting the aesthetics of the dentition. Oral rehabilitation treatment can restore the dentition health of patients and correct related oral functional issues^[5]. Oral implant therapy, as a dental prosthetic treatment technique with a relatively high clinical application rate in recent years, can actively correct the health of a patient's dentition after implant placement and crown restoration, with definite therapeutic effects. However, during the clinical application of this treatment technique, it has been found that due to the operational requirements of implant placement, it is necessary to comprehensively evaluate the bone health of the patient's implantation site and the occlusal relationship, while completing the precise placement of the implant to avoid the risk of short- and long-term complications caused by damage to adjacent teeth and periodontal tissues due to deviations in the implantation angle and position, ensuring the effectiveness and safety of the patient's treatment. Therefore, it is necessary to reasonably select oral implant guidance techniques^[6,7].

As an auxiliary technology widely applied in fields such as orthopedic repair and oral orthodontics at the current stage, 3D printing technology can provide personalized guidance plans for disease treatment by printing three-dimensional models of relevant bone structures based on three-dimensional imaging examination results of patients before treatment and conducting simulated treatment operations based on these models. This enhances the precision of actual treatment operations. Moreover, recent studies have indicated that the clinical application of 3D printing technology can actively improve the accuracy of oral implant placement and optimize the correction effects on oral function after treatment^[8]. Against the above backdrop, this study, conducted under the guidance of 3D printing technology in oral implant treatment, revealed that, compared to the control group, the observation group exhibited increased masticatory efficiency and bite force after oral implant treatment. Moreover, statistically significant differences ($p < 0.05$) were observed in the deviation values of implant crown, apical part in the sagittal plane, axial angle, and neck. Analysis indicates that the application of 3D printing technology enables the reasonable design of implant guides through the simulation of implant placement operations after printing a three-dimensional model of the patient's oral cavity. This effectively enhances the fit between the guide and the oral mucosa, providing a foundation for precise operations in implant treatment. The materials used in 3D printing are adhesive materials with high strength and resistance to deformation, which actively reduce deviations in drill bit

direction guidance caused by guide deformation in practical applications.

Additionally, the guide's stop ring structure limits drilling depth, enhancing the accuracy of implant hole preparation and implant placement operations. The hollow design of the guide ensures the effective entry of irrigation cooling water into the holes, reducing the risk of thermal injury to the bone tissue at the implant site and surrounding periodontal tissues ^[9,10]. Furthermore, compared to traditional implant guides, the production of 3D-printed implant guides involves fewer human factors, effectively avoiding the risk of positional deviations during implant placement operations.

5. Conclusion

In summary, the application of 3D printing technology in oral implant treatment can effectively reduce implant placement deviations, enhance implantation accuracy, and simultaneously correct and maintain the patient's oral bite force and masticatory function health.

Disclosure statement

The authors declare no conflict of interest.

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Analysis of the Efficacy and Effective Rate of Surgical and Conservative Treatment for Acute Appendicitis

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Abstract: *Objective:* Acute appendicitis, as a common clinical acute abdominal condition, has a significant impact on patient prognosis depending on the choice of treatment strategy. This study aims to systematically compare the clinical efficacy and safety of surgical versus conservative treatment in patients with acute appendicitis. *Methods:* A total of 60 patients with acute appendicitis admitted to our hospital from August 2024 to July 2025 were selected as the study subjects and divided into a surgical group ($n = 30$) and a conservative group ($n = 30$) based on the treatment approach. The surgical group underwent abdominal incision appendectomy, while the conservative group received antibiotic therapy combined with symptomatic supportive treatment. Evaluation indicators included the treatment effective rate, symptom relief time, and complication incidence. *Results:* The treatment effective rate in the surgical group was 96.67%, significantly higher than that in the conservative group (76.67%) ($p < 0.05$). In terms of symptom relief, the time to relief of abdominal pain (1.25 ± 0.36 days) and fever (1.08 ± 0.29 days) in the surgical group was significantly shorter than that in the conservative group (3.12 ± 0.57 days and 2.89 ± 0.61 days, respectively, $p < 0.001$). The complication rates in the two groups were 10.00% and 13.33%, respectively ($p > 0.05$). *Conclusion:* Surgical treatment for acute appendicitis demonstrates significant advantages in improving treatment efficacy and shortening the time to symptom relief, with a comparable risk of complications to conservative treatment. It is therefore worthy of clinical priority recommendation, particularly for patients without surgical contraindications.

Keywords: Acute appendicitis; Surgical treatment; Conservative treatment; Efficacy; Time to symptom relief

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1. Introduction

Acute appendicitis is one of the most common acute abdominal conditions in general surgery, with its pathogenesis primarily related to appendiceal lumen obstruction and bacterial invasion. If not promptly intervened, it can lead to serious complications such as abdominal abscesses and portal phlebitis, and may even be life-threatening^[1,2]. Currently, clinical treatment for acute appendicitis mainly involves two approaches: surgical removal of the appendix

and conservative pharmacological treatment. Surgical treatment is widely applied due to its ability to directly remove the lesion, but some patients opt for conservative treatment due to advanced age, underlying medical conditions, or personal preference^[3,4]. Based on this, this study took 60 patients with acute appendicitis admitted to our hospital from August 2024 to July 2025 as the research subjects, systematically compared the clinical effects of surgical and conservative treatments, and focused on analyzing the treatment efficacy rate and indicators related to symptom relief, aiming to provide high-quality clinical evidence for optimizing clinical treatment strategies. The research results are now reported as follows.

2. Data and methods

2.1. General information

A retrospective analysis was conducted on the medical records of patients with acute appendicitis who underwent emergency surgical treatment in our department from August 2024 to July 2025.

2.1.1. Inclusion criteria

- (1) Meeting the diagnostic criteria in the “Guidelines for the Diagnosis and Treatment of Acute Appendicitis (2022 Edition)”^[5]
- (2) Normal laboratory test results; ultrasound indicates morphological changes in the appendix accompanied by tenderness and rebound tenderness
- (3) Patients with clear etiologies and typical clinical manifestations before surgery

2.1.2. Exclusion criteria

- (1) Patients with severe complications such as appendix perforation and diffuse peritonitis
- (2) Patients with functional failure of vital organs such as the heart, liver, and kidneys who cannot tolerate surgery
- (3) Pregnant and lactating women
- (4) Patients who cannot use the experimental drugs due to other reasons
- (5) Patients with malignant tumors or other diseases affecting prognosis and those with low immunity

2.1.3. Study design

They were divided into two groups based on different treatment methods: the surgical group ($n = 30$) consisted of 18 males and 12 females, aged between 18 and 65 years old with an average age of (38.5 ± 12.3) ; the disease duration ranged from 6 to 48 hours, with an average duration of (24.3 ± 8.5) ; the disease types included 16 cases of simple appendicitis and 14 cases of purulent appendicitis. The conservative group ($n = 30$) consisted of 17 males and 13 females, aged between 19 and 64 years old with an average age of (39.2 ± 11.8) ; the disease duration ranged from 8 to 46 hours, with an average duration of (23.8 ± 9.1) ; the disease types included 15 cases of simple appendicitis and 15 cases of purulent appendicitis. A comparison of general data between the two groups (all $p > 0.05$) indicated comparability. This study was approved by the hospital's ethics committee, and both patients and their families signed informed consent forms.

2.2. Treatment methods

2.2.1. Surgical group

All patients underwent abdominal incision appendectomy, with the specific procedure as follows: The patient was placed in a supine position. After continuous epidural anesthesia or general anesthesia, an oblique incision approximately 3–5 cm in length was made at the McBurney's point in the lower right abdomen. The skin, subcutaneous tissue, and external oblique aponeurosis were sequentially incised, followed by blunt dissection of the internal oblique and transverse abdominal muscles. The peritoneum was then incised to enter the abdominal cavity. Ligate the appendix with No. 4 silk thread at a point 0.5 cm from the cecum at the root of the appendix. Then, clamp and cut the appendix at a point 0.5 cm distal to the ligation site. The residual end is disinfected sequentially with carbolic acid, alcohol, and normal saline, and is embedded into the cecal wall using absorbable sutures (pouch embedding method). After checking for no bleeding or exudate and confirming that the surgical instruments and gauze are accounted for, close the abdominal cavity layer by layer. The skin incision can be sutured intermittently with silk thread or with intradermal sutures.

2.2.2. Conservative treatment group

The treatment plan involves a combination of antibiotics and symptomatic supportive care, as follows: Administer ceftriaxone sodium (2.0 g per dose, once daily) in combination with metronidazole (0.5 g per dose, twice daily) intravenously for anti-infection. Adjust the duration of medication based on the patient's condition, typically for 7 to 10 days. Simultaneously, provide symptomatic treatments such as fasting or a liquid diet, gastrointestinal decompression (if necessary), intravenous fluid replacement to correct electrolyte imbalances, and oral administration of ibuprofen sustained-release capsules (0.3 g per dose, twice daily) for fever and pain relief. During treatment, closely monitor the patient's body temperature, abdominal pain symptoms, and changes in blood routine indicators. If symptoms worsen, inflammatory markers continue to rise, or signs of complications appear, immediately switch to surgical treatment.

2.3. Observation indicators

(1) Treatment efficacy rate

Based on the patient's clinical manifestations, physical examinations, and laboratory test results, patients are categorized into three groups: cured, effective, and ineffective. Cured refers to the resolution of symptoms such as abdominal pain and high fever after treatment, with normalization of white blood cell count and neutrophil percentage, and retraction of the appendix observed on abdominal ultrasound. Effective indicates improvement in the aforementioned indicators after treatment, but not to the extent of full recovery. Ineffective refers to cases where there is no improvement or a worsening trend in the above indicators after treatment, necessitating alternative treatment approaches. The treatment efficacy rate is calculated as $(\text{number of cured cases} + \text{number of effective cases}) / \text{total number of cases} \times 100\%$.

(2) Symptom relief time

This includes the time to relief of abdominal pain (from the start of treatment until the abdominal pain symptoms have largely subsided) and the time to relief of fever (from the start of treatment until body temperature returns to normal and remains so for more than 24 hours).

(3) Complications

Record the occurrence of complications in both groups of patients, including incision infection and abdominal adhesion in the surgical group, and intra-abdominal abscess in the conservative treatment group.

2.4. Statistical methods

Data processing was conducted using SPSS 26.0 statistical software. Measurement data were expressed as ($\bar{x} \pm s$), and comparisons between groups were made using the *t*-test, with data rounded to two decimal places. Count data were expressed as [n (%)], and comparisons between groups were made using the χ^2 test. A *p*-value of less than 0.05 was considered statistically significant.

3. Results

3.1. Comparison of treatment efficacy between the two groups of patients

The treatment efficacy in the surgical group was significantly higher than that in the conservative group ($p < 0.05$). Specific data are shown in **Table 1**.

Table 1. Comparison of treatment efficacy between the two groups of patients [n (%)]

Group	Cured	Effective	Ineffective	Treatment effective rate
Surgical (n = 30)	22 (73.33)	7 (23.34)	1 (3.33)	29 (96.67)
Conservative (n = 30)	15 (50.00)	8 (26.67)	7 (23.33)	23 (76.67)
χ^2 -value				5.192
<i>p</i> -value				0.023

3.2. Comparison of symptom relief time between the two groups of patients

The relief times for abdominal pain and fever in the surgical group were significantly shorter than those in the conservative group (both $p < 0.001$). Specific data are shown in **Table 2**.

Table 2. Comparison of symptom relief time between the two groups of patients ($\bar{x} \pm s$, d)

Group	Abdominal pain relief time	Fever relief time
Surgical (n = 30)	1.25 \pm 0.36	1.08 \pm 0.29
Conservative (n = 30)	3.12 \pm 0.57	2.89 \pm 0.61
<i>t</i> -value	15.193	15.215
<i>p</i> -value	0.000	0.000

3.3. Comparison of complication incidence between the two groups of patients

In the surgical group, there were 2 cases of incision infection and 1 case of abdominal adhesion, with a complication rate of 10.00%. In the conservative group, there were 3 cases of abdominal abscess and 1 case of symptom aggravation, with a complication rate of 13.33%. The comparison of complication rates between the two groups showed ($\chi^2 = 0.162$, $p = 0.688$). All patients with complications recovered after symptomatic treatment.

4. Discussion

Acute appendicitis is a disease characterized by obstruction and secondary infection of the appendiceal tissue as its fundamental etiology, accompanied by corresponding pathological changes (including local congestion

and edema, accumulation of exudate, and adherence of fibrinopurulent exudate). When severe damage occurs to the appendiceal mucosa, it can lead to more severe infiltration of plasma cells in the submucosa, aggregation of neutrophils, and increased vascular permeability, resulting in fluid extravasation and ultimately gangrene of the appendiceal wall ^[6]. The sequence of “obstruction-infection-necrosis” forms an irreversible vicious cycle ^[7]. The primary objective of surgery is to remove the primary lesion, the diseased appendix, and thoroughly clear the surrounding inflammation, thereby halting disease progression and preventing a series of systemic and local complications caused by appendiceal perforation. This is also the fundamental reason for the favorable outcomes achieved with surgical treatment ^[8]. Conservative treatment, on the other hand, primarily targets bacterial inflammation caused by the proliferation of normal parasitic flora in the intestinal tract. Empirical treatment with antibiotics based on this can control disease progression but cannot resolve appendiceal lumen obstruction, which is the key factor contributing to its relatively lower treatment efficacy and the risk of recurrence ^[9].

The results of this study show that the effective treatment rate in the surgical group was 96.67%, significantly higher than the 76.67% in the conservative group. This data is highly consistent with the pathological mechanism of acute appendicitis. After surgical removal of the appendix, the focus is completely cleared, eliminating the basis for persistent inflammation. Consequently, the cure rate reaches as high as 73.33%, with only one case deemed ineffective due to postoperative incision infection. In contrast, 23.33% of patients in the conservative group experienced ineffective treatment, primarily because the obstruction of the appendiceal lumen was not relieved, allowing bacteria to continue proliferating and leading to prolonged inflammation. Some patients even experienced worsening inflammation and required conversion to surgical treatment.

In terms of symptom relief time, the surgical group exhibited significantly shorter durations for both abdominal pain and fever relief compared to the conservative group, highlighting the direct advantages of surgical treatment. After surgical removal of the focus, abdominal pain symptoms can quickly improve within 1–2 days postoperatively due to the elimination of the primary cause of the inflammatory response. The conservative group, on the other hand, relies on anti-infective drugs to gradually control pathogenic bacteria, resulting in slower dissipation of inflammatory markers and a more gradual recovery of corresponding symptoms. In this study, the average time for abdominal pain relief in the conservative group reached 3.12 days, while fever relief time was 2.89 days, showing significant differences compared to the surgical group. This provides data support for choosing surgical treatment for patients who require rapid symptom relief in clinical practice ^[10].

Regarding the incidence of complications, there was no significant difference between the two groups, a result that challenges the traditional belief that surgical treatment carries a higher risk of complications. The surgical group underwent appendectomy via abdominal incision and, through strict aseptic procedures during surgery, incision protection, and standardized postoperative anti-infective treatment, the incidence of incision infection was only 6.67%. Although the conservative group did not experience surgical trauma, due to inadequate and untimely control of inflammation, the incidence of abdominal abscess reached 10.00%. This suggests that both treatment options carry a certain risk of complications, and the key lies in standardizing the treatment process.

This study has certain limitations. First, this study is a single-center retrospective case series with a relatively small number of enrolled cases (a total of 60 cases), which may introduce selection bias. Second, no follow-up was conducted, the long-term recurrence rate in patients receiving conservative treatment was not statistically analyzed. Future research could involve multi-center prospective studies with larger sample sizes, incorporating long-term follow-up data and pathological classifications for more in-depth analysis.

5. Conclusion

In summary, surgical treatment for acute appendicitis is significantly superior to conservative treatment in terms of treatment efficacy and the speed of symptom relief, with no significant difference in the incidence of complications between the two treatment options. In clinical practice, for patients with acute appendicitis who have no surgical contraindications, abdominal incision appendectomy should be the preferred choice; for patients with surgical contraindications or those who strongly refuse surgery, conservative treatment can be adopted, but close monitoring of the patient's condition is necessary. Once signs of ineffective treatment or complications appear, immediate conversion to surgical treatment should be implemented.

Disclosure statement

The author declares no conflict of interest.

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