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Clinical Effect of Nimodipine Combined with Rosuvastatin Calcium in the Treatment of Hypertensive Intracerebral Hemorrhage

Yanting Wang, Xiaogang Wang*

Department of Neurosurgery, The 960th Hospital of the Joint Logistic Support Force of the Chinese People's Liberation Army, Jinan 250000, Shandong Province, China

*Corresponding author: Xiaogang Wang, wangxiaogangnn@126.com

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Abstract: *Objective:* To explore the clinical effect of nimodipine combined with rosuvastatin calcium in the treatment of hypertensive intracerebral hemorrhage. *Methods:* Sixty patients with hypertensive intracerebral hemorrhage from January 2023 to December 2023 were randomly divided into a control group ($n = 30$) and an observation group ($n = 30$). The control group received conventional treatment, while the observation group was treated with nimodipine + rosuvastatin calcium tablets. The neurological function, edema volume, hematoma volume, adverse reactions, and treatment efficiency were compared between the two groups. *Results:* After treatment, compared with the control group, the edema volume, hematoma volume index, and NIHSS score in the observation group were all reduced, and the differences were extremely significant ($P < 0.001$). The clinical efficacy of the observation group was 93.33%, which was much higher than the 66.67% of the control group, and the difference was significant ($P < 0.05$). The incidence of adverse reactions in the observation group was 3.33%, which was far lower than the 30.00% of the control group, and the difference was significant ($P < 0.05$). *Conclusion:* Nimodipine combined with rosuvastatin calcium in the treatment of hypertensive intracerebral hemorrhage shows significant advantages in improving edema volume and hematoma volume, promoting neurological recovery, improving clinical efficacy, and reducing the incidence of adverse reactions, thus having broad clinical application prospects.

Keywords: Nimodipine; Rosuvastatin calcium; Hypertensive intracerebral hemorrhage; Clinical effect

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1. Introduction

Hypertensive intracerebral hemorrhage is a common and serious cerebrovascular disease characterized by high morbidity, high disability rate, and high mortality rate^[1]. Its pathogenesis is mainly due to pathological changes in small cerebral arteries caused by long-term hypertension, leading to cerebral vascular rupture and bleeding

when blood pressure rises suddenly. After a cerebral hemorrhage, local brain tissue will undergo pathological changes such as hematoma compression and secondary cerebral edema, which can lead to neurological deficits [2]. Currently, there are various clinical treatments for hypertensive intracerebral hemorrhage, but the efficacy still needs to be further improved. Nimodipine is a neuroprotective calcium channel blocker, and rosuvastatin calcium is a statin lipid-lowering drug. Recent studies have found that it has pleiotropic effects, including anti-inflammatory, antioxidant, and improvement of endothelial function. This study aims to explore the clinical effect of nimodipine combined with rosuvastatin calcium in the treatment of hypertensive intracerebral hemorrhage, providing a reference for clinical treatment.

2. Materials and methods

2.1. General information

Sixty patients with hypertensive intracerebral hemorrhage admitted between January 2023 and December 2023 were selected as research subjects. The patients were divided into a control group and an observation group according to the random number table method, with 30 patients in each group.

Control group: 18 males and 12 females; aged between 45–78 years, with an average age of (62.51 ± 8.34) years; bleeding site: 15 cases in the basal ganglia region, 10 cases in the lobes, and 5 cases in the thalamus; bleeding volume: 5–15ml, with an average of (10.55 ± 2.21) ml.

Observation group: 16 males and 14 females; aged between 42–75 years, with an average age of (60.82 ± 7.93) years; bleeding site: 13 cases in the basal ganglia region, 12 cases in the lobes, and 5 cases in the thalamus; bleeding volume: 5–15ml, with an average of (11.32 ± 1.52) ml. There was no statistically significant difference in general information such as gender, age, bleeding site, and bleeding volume between the two groups ($P > 0.05$), indicating comparability.

Inclusion criteria: (1) Meet the diagnostic criteria for hypertensive intracerebral hemorrhage; (2) The onset time is within 24–72 hours; (3) The patient or family members have signed an informed consent form.

Exclusion criteria: (1) Those with severe cardiac, liver, or kidney dysfunction; (2) Those with a bleeding tendency or coagulation dysfunction; (3) Those who are allergic to nimodipine or rosuvastatin calcium; (4) Those with a history of cerebral vascular malformations, brain tumors, or other brain diseases.

2.2. Methods

2.2.1. Control group

Conventional treatment methods were adopted: (1) Patients need to rest in bed, maintain a quiet environment, and avoid emotional excitement, as these external stimuli may cause blood pressure fluctuations and aggravate the condition of cerebral hemorrhage. (2) Based on the patient's intracranial pressure, mannitol, a dehydrating agent that reduces intracranial pressure, was administered. Mannitol can effectively reduce brain tissue edema and lower intracranial pressure. However, the specific dosage must be precisely adjusted based on the patient's actual intracranial pressure to ensure both therapeutic effectiveness and the avoidance of adverse reactions. (3) Strictly control the patient's blood pressure, maintaining it within the range of 140–160/90–100 mmHg. Stable blood pressure is crucial to prevent further deterioration of cerebral hemorrhage. (4) Maintain the patient's water and electrolyte balance and provide nutritional support to ensure the normal functioning of the patient's bodily functions. (5) Actively prevent and treat complications such as pulmonary infections and stress ulcers.

2.2.2. Observation group

In addition to conventional treatment, a treatment regimen combining nimodipine and rosuvastatin calcium was added. The initial dose of nimodipine (manufacturer: Tianjin Central Pharmaceutical Co., Ltd.; specification: 20 mg x 50 tablets) was 30 mg per time, taken orally three times a day. The dosage could be gradually increased to 60 mg per time, also taken orally three times a day, based on the patient's condition and tolerance. Rosuvastatin calcium (manufacturer: Wuhan Mingsheng Technology Co., Ltd.; specification: 10 mg x 28 tablets) was administered at a dose of 10 mg per time, taken orally once a day. Both groups of patients were treated continuously for 4 weeks.

2.3. Observation indices

2.3.1. Imaging indices

Edema volume: The volume of cerebral edema in patients was measured using head CT scans before treatment and after 4 weeks of treatment. The edema volume was calculated using a specific formula through professional image analysis software.

Hematoma volume: Similarly, before treatment and after 4 weeks of treatment, the hematoma volume was calculated using the Tada formula (hematoma volume = $\pi/6$ x length axis x short axis x slice number) through head CT scans.

2.3.2. Neurological function

The National Institutes of Health Stroke Scale (NIHSS) score was used to evaluate patients' neurological function, with assessments conducted before treatment and after 4 weeks of treatment. The maximum score is set to 42, and a higher score indicates a more severe degree of neurological impairment.

2.3.3. Clinical efficacy

Based on the clinical symptoms, signs, and imaging examination results of patients after treatment, the treatment effect was divided into three levels: significantly effective, effective, and ineffective.

Significantly effective: The clinical symptoms and signs of patients improved significantly, NIHSS score decreased by $\geq 70\%$, and edema and hematoma volumes decreased by $\geq 50\%$.

Effective: The clinical symptoms and signs of patients improved somewhat, with a $30\% \leq$ NIHSS score decrease $< 70\%$, and a $20\% \leq$ decrease in edema and hematoma volumes $< 50\%$.

Ineffective: The clinical symptoms and signs of patients showed no significant improvement or even worsened, NIHSS score decreased by $< 30\%$, and edema and hematoma volumes decreased by $< 20\%$.

Treatment effectiveness rate = (number of significantly effective cases + number of effective cases) / total number of cases x 100%.

2.3.4. Adverse reactions

Adverse reactions that occurred during treatment in both groups of patients were observed and recorded, including nausea, gastrointestinal bleeding, transient dizziness, etc.

2.4. Statistical methods

Data analysis was performed using SPSS 27.0. Measurement data were expressed as (\pm SD) and analyzed using the *t*-test. Count data were expressed as [n(%)] and analyzed using the χ^2 test. A *P*-value < 0.05 was considered statistically significant.

3. Results

3.1. Comparison of imaging indices between the two groups

Before treatment, there was no significant difference in edema volume and hematoma volume between the two groups. After treatment, compared with the control group, the observation group showed significantly reduced edema volume (1.30 ± 0.15 mL vs. 2.34 ± 0.33 mL) and hematoma volume (9.84 ± 1.16 mL vs. 15.29 ± 1.21 mL), with extremely significant differences ($P < 0.001$), as shown in **Table 1**.

Table 1. Comparison of edema volume and hematoma volume indices between the two groups (\pm SD, mL)

Group	Number of cases (n)	Edema volume		Hematoma volume	
		Before treatment	After treatment	Before treatment	After treatment
Control group	30	6.41 ± 1.26	2.34 ± 0.33	20.15 ± 3.50	15.29 ± 1.21
Observation group	30	6.38 ± 1.20	1.30 ± 0.15	20.24 ± 3.36	9.84 ± 1.16
<i>t</i> value		0.094	15.714	0.102	17.809
<i>P</i> value		0.925	<0.001	0.919	<0.001

3.2. Comparison of neurological function between the two groups of patients

Before treatment, the NIHSS scores of the two groups were similar, and there was no statistically significant difference. After treatment, the NIHSS score of the observation group was lower than that of the control group, and the difference was extremely significant ($P < 0.001$), as shown in **Table 2**.

Table 2. Comparison of NIHSS scores between the two groups of patients (\pm SD, score)

Group	Number of cases (n)	NIHSS score	
		Before treatment	After treatment
Control group	30	23.11 ± 3.20	15.27 ± 1.35
Observation group	30	23.20 ± 3.17	6.47 ± 1.24
<i>t</i> -value		0.109	27.375
<i>P</i> -value		0.913	<0.001

3.3. Comparison of clinical efficacy between the two groups of patients

The clinical efficacy of the observation group was 93.33%, which was much higher than the 66.67% of the control group, and the difference was significant ($P = 0.010 < 0.05$), as shown in **Table 3**.

Table 3. Comparison of clinical efficacy between the two groups of patients [n(%)]

Group	n	Marked effect	Effective	Ineffective	Total effective rate
Control group	30	10 (33.33%)	10 (33.33%)	10 (33.33%)	20 (66.67%)
Observation group	30	20 (66.67%)	8 (26.67%)	2 (6.67%)	28 (93.33%)
χ^2 value	-	-	-	-	6.667
<i>P</i> value	-	-	-	-	0.010

3.4. Comparison of the incidence of adverse reactions between the two groups

The incidence of adverse reactions in the observation group was 3.33%, which was significantly lower than the 30.00% in the control group ($P = 0.006 < 0.05$), as shown in **Table 4**.

Table 4. Comparison of the incidence of adverse reactions between the two groups [n(%)]

Group	n	Gastrointestinal bleeding	One-time dizziness	Nausea	Total adverse reaction rate
Control group	30	3 (10.00%)	4 (13.33%)	2 (6.67%)	9 (30.00%)
Observation group	30	0 (0.00%)	1 (3.33%)	0 (0.00%)	1 (3.33%)
χ^2 value					7.680
P value					0.006

4. Conclusion

In the field of neurosurgery, hypertensive intracerebral hemorrhage is a quite common disease with a persistently high incidence rate. As the incidence of hypertension continues to rise in the population, the occurrence of hypertensive intracerebral hemorrhage has shown a more pronounced growth trend in recent years. According to relevant research data and clinical observations, this increasing trend is closely related to the increase in the number of hypertensive patients [3]. Nimodipine is a commonly used antihypertensive drug in clinical treatment, and as a typical representative of calcium channel blockers, it has a unique pharmacological mechanism. Besides its basic effect of lowering blood pressure, nimodipine can also exert specific effects on nerve cells and cerebrovascular vessels. By regulating calcium ion channels, nimodipine can affect the excitability of nerve cells and the contractile state of cerebrovascular vessels, thereby playing a positive role in improving cerebral blood circulation, reducing cerebral ischemic injury, and protecting nerve cells [4–5]. Rosuvastatin calcium, on the other hand, is a commonly used lipid-lowering drug in clinical practice. Its main pharmacological effect lies in its ability to effectively reduce the level of lipoprotein cholesterol in the plasma and inhibit the synthesis process of cholesterol. In long-term clinical application, the lipid-lowering effect of rosuvastatin calcium has been widely confirmed and recognized. Many patients have achieved significant improvements in their blood lipid indicators after using this drug, thereby reducing the risk of cardiovascular disease and other related complications [6–7]. Both drugs occupy important positions in their respective pharmacological fields, laying a foundation for subsequent research on combination therapy for hypertensive intracerebral hemorrhage.

This study suggests that the observation group exhibited significant advantages over the control group in multiple aspects in the treatment of hypertensive intracerebral hemorrhage. After treatment, the observation group showed significant improvement in key indicators such as edema volume, hematoma volume, and NIHSS score. This is primarily attributed to the synergistic mechanism of the combined drug regimen. As a calcium channel blocker, nimodipine can effectively dilate cerebral blood vessels, improve cerebral blood circulation, and reduce a series of pathophysiological changes caused by local ischemia and hypoxia. This inhibits the further development of edema around the hematoma and promotes hematoma absorption [8]. At the same time, it has a protective effect on nerve cells, can reduce nerve damage, and contribute to the recovery of nerve function. Rosuvastatin calcium plays an important role due to its pleiotropic effects. It can regulate lipid metabolism, stabilize vascular endothelial function, and reduce vascular wall damage and inflammation. Through anti-inflammatory and antioxidant effects, it can reduce the inflammatory cascade reaction after cerebral hemorrhage, alleviate secondary damage to brain

tissue, further promote edema subsidence and hematoma absorption, and create favorable conditions for the repair of nerve function ^[9]. In terms of clinical efficacy, the significant improvement in the observation group benefits from the cooperation of the two drugs, which intervene in the complex pathological process after hypertensive intracerebral hemorrhage from different pathological links, thereby effectively improving patients' symptoms and signs and enhancing the effectiveness of treatment. Regarding the incidence of adverse reactions, the advantage of the observation group may be due to the reasonable dosing combination of the two drugs during combination therapy, and their respective mechanisms of action are adjusted to a certain extent, reducing the possible adverse reactions caused by a single drug and making the overall treatment process safer and more tolerable ^[10–11].

In summary, the combination of nimodipine and rosuvastatin calcium has a significant clinical effect in the treatment of hypertensive intracerebral hemorrhage. It stands out in improving patients' conditions, enhancing treatment efficiency, and reducing the risk of adverse reactions. This provides a more effective treatment strategy for the clinical treatment of hypertensive intracerebral hemorrhage and is worthy of further promotion and application in clinical practice, as well as deeper research on its mechanism of action, to better serve patients.

Disclosure statement

The authors declare no conflict of interest.

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To Analyze the Effect of Hemodialysis, Hemoperfusion, and Oral Olanzapine on Uremic Encephalopathy

Yueyue He*

Boe Hospital of Suzhou, Suzhou 215217, Jiangsu Province, China

*Corresponding author: Yueyue He, heyueyue19850315@163.com

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Abstract: *Objective:* To analyze the effects of hemodialysis, hemoperfusion, and oral olanzapine in patients with uremic encephalopathy. *Methods:* 70 patients with uremic encephalopathy admitted to the hospital from January 2023 to August 2024 were selected and divided into groups according to a random drawing method, with 35 cases in each group. The control group was treated with hemodialysis and olanzapine orally, and the observation group was treated with hemoperfusion. PANSS scores, biochemical indexes, and inflammatory factors were compared between the two groups. *Results:* PANSS score, biochemical indexes, and inflammatory factors in the observation group were significantly lower than those in the control group ($P < 0.05$). *Conclusion:* The triple therapy of hemodialysis, hemoperfusion, and olanzapine can obviously promote the improvement of the psychological state of the patients. In addition, this treatment can also relieve inflammation in the patients and accelerate the excretion of toxins in the body.

Keywords: Hemodialysis; Hemoperfusion; Oral olanzapine; Triple scheme; Uremic encephalopathy

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1. Introduction

Uremic encephalopathy is a disease of central nervous system dysfunction in patients with chronic renal failure due to toxin accumulation and electrolyte imbalance. This disease is characterized by insidious onset, high incidence, great harm, and high fatality rate, which not only threatens the life and health of patients and reduces their quality of life but also increases family pressure and economic burden^[1]. Hemodialysis and blood perfusion are currently commonly used in the clinical treatment of this disease to help patients extend their survival time and improve their quality of life. However, the two treatment methods have a long course of treatment and are affected by many aspects, and the patient's psychological state is not ideal, resulting in poor treatment cooperation. Antipsychotics are needed to effectively inhibit the deterioration of uremic encephalopathy. As a new generation of antipsychotic drugs, Olanzapine has high safety and has shown good efficacy in changing mental and behavioral

aspects^[2]. Therefore, this study selected 70 patients with urotoxic encephalopathy as the enrolled subjects to carry out a study on the clinical efficacy of triple hemodialysis plus blood perfusion plus olanzapine for this disease, as reported below.

2. Data and methods

2.1. General information

A total of 70 patients with uremic encephalopathy admitted to the hospital from January 2023 to August 2024 were selected and divided into groups according to a random drawing method, with 35 cases in each group. Observation group: 20 male and 15 female, 25–76 years old, mean 48.56 ± 6.71 years old. The control group: 19 male and 16 female, 26–77 years old, mean 48.36 ± 6.93 years old. Comparison of general data ($P > 0.05$).

2.2. Methods

After hospitalization, all enrolled subjects were given basic treatment such as hypotensive, hypoglycemic, and acid-base balance.

The control group was treated with hemodialysis + olanzapine orally, with hemodialysis for 4 h each time, twice a week; Olanzapine tablets, taken orally, 5 mg once a day. According to the actual situation of the patient, the drug should be reasonably increased, and the maximum daily dose should not exceed 10 mg^[3–5]. Continuous treatment for 2 weeks.

In the observation group, hemoperfusion therapy was added to the above treatment, and the treatment lasted for 2 hours at first. After the perfusion apparatus reached saturation, the treatment was changed to hemodialysis therapy for 2 hours, twice a week^[6–10]. The administration method of olanzapine tablets was the same as that of control group.

The hemodialysis machines, dialyzers, and olanzapine tablets used in both groups were supplied by the same manufacturer and had the same specifications and models.

2.3. Observation indicators

PANSS score was compared. The PANSS scale (full name: Positive and Negative Psychiatric Symptoms Rating Scale) was used for assessment, with a score range of 0–108 points. The higher the score, the worse the mental condition.

Biochemical indexes and inflammatory factors were compared.

2.4. Statistical analysis

SPSS 22.0 was used to analyze the relevant data.

3. Results

3.1. Comparison of PANSS scores

After treatment, the PANSS scores of the two groups were significantly different ($P < 0.05$) (**Table 1**).

Table 1. Comparison of PANSS scores (Mean \pm SD, points)

Group	<i>n</i>	Negative symptom		Positive symptom		General psychopathology		Total points	
		Pre-treatment	Post-treatment	Pre-treatment	Post-treatment	Pre-treatment	Post-treatment	Pre-treatment	Post-treatment
Observation group	35	24.18 \pm 2.36	10.30 \pm 2.11	27.20 \pm 2.41	9.01 \pm 2.33	28.27 \pm 2.86	12.01 \pm 2.17	82.36 \pm 2.56	32.40 \pm 2.09
Control group	35	24.25 \pm 2.41	16.85 \pm 2.20	27.26 \pm 2.50	16.80 \pm 2.40	28.33 \pm 2.91	21.98 \pm 2.25	82.44 \pm 2.61	55.70 \pm 2.27
<i>t</i>	-	0.123	12.712	0.102	13.778	0.087	18.869	0.129	44.673
<i>P</i>	-	0.903	0.000	0.919	0.000	0.931	0.000	0.897	0.000

3.2. The values of biochemical indexes and inflammatory factors were compared between the two groups

The values of biochemical indexes and inflammatory factors in the observation group were significantly lower than those in the control group ($P < 0.05$) (Table 2).

Table 2. Comparison of biochemical indexes and inflammatory factors between the two groups (Mean \pm SD)

Group	<i>n</i>	iPTH (pg/mL)		β 2-MG (mg/L)	
		Pre-treatment	Post-treatment	Pre-treatment	Post-treatment
Observation group	35	603.63 \pm 220.10	171.30 \pm 10.40	16.95 \pm 2.60	6.01 \pm 0.90
Control group	35	600.02 \pm 221.24	196.30 \pm 12.33	17.10 \pm 2.75	7.08 \pm 1.09
<i>t</i>	-	0.068	9.169	0.234	4.478
<i>P</i>	-	0.946	0.000	0.815	0.000

Group	<i>n</i>	hs-CRP (mg/L)		IL-6 (pg/mL)		TNF- α (pg/mL)	
		Pre-intervention	Post-intervention	Pre-intervention	Post-intervention	Pre-intervention	Post-intervention
Observation group	35	16.80 \pm 3.11	11.20 \pm 1.90	14.39 \pm 3.39	5.58 \pm 1.21	86.13 \pm 12.11	22.31 \pm 3.41
Control group	35	16.85 \pm 3.16	13.35 \pm 2.10	14.44 \pm 3.46	6.81 \pm 1.40	86.20 \pm 13.01	29.33 \pm 4.44
<i>t</i>	-	0.067	4.491	0.061	3.932	0.023	7.418
<i>P</i>	-	0.947	0.000	0.952	0.000	0.982	0.000

4. Discussion

Uremic encephalopathy is a common clinical disease that has a great impact on patients' health and daily life. In the past, clinical treatment was mostly through hemodialysis and hemoperfusion, among which hemodialysis uses the semi-permeable membrane principle to remove metabolic waste, excess water, and toxins in the blood of patients, maintain electrolyte balance and acid-base balance, and reduce the symptoms of uremic encephalopathy. However, hemoperfusion further removes middle molecular toxins (such as β 2 microglobulin, etc.) from the blood through adsorbents in the perfusion device, which are often difficult to clear through hemodialysis^[10–15]. However, clinical findings show that hemodialysis and hemoperfusion treatment are not ideal for uremic encephalopathy

patients, and psychiatric drugs need to be added to improve the mental condition of patients and improve the curative effect. Olanzapine is a second-generation antipsychotic drug (SGA), which relies on blocking dopamine receptors in the central nervous system to effectively relieve positive symptoms (such as hallucinations, delusions, etc.) and negative symptoms (such as social withdrawal, emotional retarding, etc.) in patients with mental disorders. The triple regimen of hemodialysis, hemoperfusion, and oral olanzapine is applied to patients with urotoxic encephalopathy to give full play to their respective advantages and synergistic effect at the same time to improve the treatment compliance of patients, thus improving the effect of hemodialysis and perfusion on the removal of metabolic waste and toxins in the patients, reducing the inflammation of patients, and improving the quality of life of patients^[15–20].

In summary, the triple regimen of hemodialysis, hemoperfusion, and oral olanzapine has significant advantages and effects in the treatment of uremic encephalopathy and is worthy of clinical promotion and application.

Disclosure statement

The author declares no conflict of interest.

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Comprehensive Analysis of Different Laser Devices Treating Lower Extremity Varicose Veins at the Same Power and LEED Value

Zhiqi Song*

The Third People's Hospital of Huizhou, Vascular Surgery, Huizhou 516001, Guangdong Province, China

*Corresponding author: Zhiqi Song, 13199221109@163.com

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Abstract: *Objective:* To compare the clinical efficacy and complication rate of Biolitec laser and Halo laser for the treatment of lower extremity great saphenous vein (GSV) and small saphenous vein (SSV) under the same LEED value. *Methods:* A total of 70 cases of GSV and 30 cases of SSV treated with laser in our hospital from May 2022 to May 2023 were selected and treated with Biolitec and Halo laser equipment, respectively. The working mode was continuous mode. The patients were divided into the Biolitec group (35 patients with GSV and 15 patients with SSV) and the Halo group (35 patients with GSV and 15 patients with SSV) according to different laser equipment. The days of returning to normal activity, closure rate, and changes in venous clinical severity score (VCSS) were evaluated. Safety endpoints were deep vein thrombosis (DVT), heat-induced thrombosis (EHIT), surgical site ecchymosis, postoperative paresthesia (numbness), postoperative edema, burns, superficial phlebitis, and other adverse events. *Results:* There were no significant differences in the days of postoperative recovery, the closure rate of varicose veins, the change of VCSS, and the incidence of postoperative complications between the two groups. *Conclusions:* The Biolitec and the Halo laser have the same efficacy and safety in treating the GSV and SSV under the same power and LEED.

Keywords: Laser equipment; Great saphenous vein; Small saphenous vein; VCSS

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1. Introduction

Varicose veins of the lower extremities is a common vascular disease, with an incidence of 20% in general surgery ^[1-2]. The early clinical symptoms of patients with lower extremity varicose veins are limb edema, heavy fatigue, and superficial vein dilatation ^[2-4]. Due to venous stasis, traditional treatment methods such as high ligation and stripping of the great saphenous vein (GSV) are effective, but there are some disadvantages such as surgical injury, delayed recovery, and other complications ^[5-7]. With the development of medical technology, minimally invasive treatment has gradually become the current trend. Intravenous laser ablation therapy (EVLA),

as a new minimally invasive treatment method, provides a new option for the treatment of lower extremity varicose veins [8–9]. The aim of this study was to compare the clinical effectiveness and complication rates of Biolitec and Halo, two common laser devices, for the treatment of lower extremity GSV and small saphenous veins (SSV) with the same power and LEED.

2. Materials and methods

2.1. General information

From May 2022 to May 2023, patients with lower extremity GSV and SSV varicose treated with laser in our hospital were selected. Among them, 70 patients with varicose GSV of lower extremity were randomly divided into an observation group and a control group, with 35 cases in each group. The observation group was treated with Halo laser equipment, including 20 males and 15 females. The control group was treated with Biolitec laser equipment, including 18 males and 17 females. A total of 30 patients with SSV varicose of lower limbs were randomly divided into the observation group and the control group, with 15 cases in each group. The observation group was treated with Halo laser equipment, including 8 males and 7 females. The control group was treated with Biolitec laser equipment, including 7 males and 8 females.

Inclusion criteria: (1) patients aged 20–75 years old; (2) complete medical records; (3) all patients were diagnosed by clinical symptoms, signs, and imaging examination showing that the deep veins of the lower limbs were unobstructed and the GSV had venous reflux. Primary varicose vein of lower extremity was diagnosed by imaging examination. (4) The patient was in normal consciousness and could cooperate with the operation, and the related indicators were tested, and there was no serious mental disease or other contraindications. (5) Clinical etiology anatomy pathophysiology (CEAP) grades C1-2 to C4. (6) All patients had signed the informed consent.

Exclusion criteria: (1) Complicated with serious diseases of vital organs; (2) iliac vein compression; (3) post-thrombotic syndrome; (4) severe allergic constitution; (5) pregnant or lactating women; (6) patients with surgical contraindications; (7) lost in follow-up.

There was no statistically significant difference in the general data between the two groups ($P > 0.05$), as shown in **Tables 1** and **2**.

Table 1. Comparison of general data between the two groups of patients with varicose great saphenous vein of lower extremities [$n = 35$, (Mean \pm SD)]

Groups	Age (Years)	Duration of disease (Years)	Gender (Cases)	Affected sides			CEAP classification			
			Male/Female	Left side	Right side	Bilateral	Lv.C1–C2	Lv.C3	Lv.C4a	Lv.C4b
Observation group	56.23 \pm 8.09	4.31 \pm 2.15	20/15	14	13	8	7	14	8	6
Control group	55.83 \pm 9.30	4.23 \pm 2.30	18/17	15	11	9	8	12	9	6
t/x^2	0.192	0.161	0.227		0.260			0.279		
P	0.848	0.873	0.634		0.0608			0.0630		

Table 2. Comparison of general data between two groups of patients with varicose small saphenous vein of lower extremity

Groups	Age (Years)	Duration of disease (Years)	Gender (Cases)	Affected sides			CEAP classification			
			Male/Female	Left side	Right side	Bilateral	Lv.C1–C2	Lv.C3	Lv.C4a	Lv.C4b
Observation group	56.13 ± 6.77	4.13 ± 1.64	8/7	6	6	3	2	5	5	3
Control group	55.93 ± 6.30	4.07 ± 1.22	7/8	7	5	3	1	6	4	4
<i>t/x²</i>	0.084	0.126	0.129		0.168			0.493		
<i>P</i>	0.934	0.900	0.719		0.919			0.782		

2.2. Treatment methods

2.2.1. Instruments and consumables

Observation group: Halo Diode Laser System (Micro-Energy Medical Technology Co., Ltd), using the same company fiber, Halo-R-0.40-2.5, Halo-R-0.60-2.5.

Control group: Ceralas E Laser System (Biolitec AG, CeramOptecCeramOptec GmbH), using the same company fiber, ELVeS Radial 400 µm, 600 µm.

2.2.2. Procedures

The patients' medical history was collected and confirmed. On the day of treatment, the patients were examined physically and underwent imaging examination to determine the venous position, reflux, and surface markers. The patient was placed in the supine position, and local injection anesthesia was used. Tumescence anesthesia solution was prepared by mixing 500 ml of Hartmann's solution with 20 ml of 2% lidocaine, and perivenous infiltration injection was performed under intraoperative ultrasound guidance, ensuring that the vein was at least 10 mm away from the skin after injection. A vascular sheath was used to obtain access, and a laser fiber connected to a laser therapeutic system was inserted into the GSV/SSV through the vascular sheath for ablation. Treatment parameters were set according to the requirements of the Guidelines for Diagnosis and Treatment of Common Venous Diseases (2022 Edition) [6]. The GSV in the observation group was treated with Halo-R-0.60-2.5 fiber, and the GSV in the control group was treated with ELVeS Radial 600 µm fiber. Other parameters were set in continuous mode, laser power was set at 6 to 8w, and LEED was 50 J/cm. The SSV in the observation group was treated with Halo-R-0.40-2.5 fiber, and the SSV in the control group was treated with ELVeS Radial 400 µm fiber. The other parameters were set in continuous mode, the laser power was set to 4–5 W, and the LEED was 40 J/cm. For GSV treatment, ablation was initiated 2 cm distal to the saphenofemoral junction (SFJ) but did not extend below the knee joint region. SSV ablation was performed by puncture in the lower leg, and the ablation site was started 2 cm distal to the saphenous popliteal junction. During the laser ablation, the patient was kept in a 30-degree head-down position. After the whole ablation procedure, the lower limbs were then wrapped with elastic bandages.

2.2.3. Postoperative management

Passive mobilization of the affected limb was performed immediately after operation to prevent deep vein thrombosis (DVT) of the lower extremity. Clinical observation of the blood supply of the affected limb and the condition of the dorsalis pedis artery were performed. The patients were encouraged to walk independently off the bed 6 hours after

operation. Aescufen forte was given orally twice a day (2 tablets each time) for at least 3 months after surgery. The elastic bandage was replaced by medical elastic stockings (long-legged above the knee, second-level pressure) 2 days after operation and continued to be used for 3 months or more. If the Carprini score was ≥ 5 , prophylactic anticoagulation therapy was performed by subcutaneous injection of enoxaparin 4000U, once every 24 hours for 7 days.

2.3. Observation indicators

The time required for patients to return to normal activities after surgery and the short-term (0 time, 1 month, 3 months) and long-term (12 months) venous closure rate after surgery were compared between the two groups. The changes of the venous clinical severity score (VCSS) before and after treatment were compared between the two groups.

The incidence of postoperative DVT, heat-induced thrombosis (EHIT), surgical site ecchymosis, postoperative paresthesia (numbness), postoperative edema, burns, superficial phlebitis, and other adverse events were observed.

2.4. Statistical methods

Statistical software was used for data analysis. Measurement data were expressed as (Mean \pm SD), and a *t* test was used for comparison between groups. Count data were expressed as rate (%), and an χ^2 test was used for comparison between groups. $P < 0.05$ was considered statistically significant.

3. Results

3.1. Short-term and long-term postoperative closure rate

At 0 time after operation, the vein closure rate of the two groups was 100%. At 1 month, 3 months, and 12 months, the closure rates of the two groups decreased, but there was no significant difference between the two groups ($P > 0.05$), as shown in **Tables 3** and **4**.

Table 3. Comparison of surgical closure rate between two groups of great saphenous vein varices of lower extremity [$n = 35$, n/(%)]

Groups	At 0 time*	1 month*	3 month*	12 month*
Observation group	35 (100%)	35 (100%)	35 (100%)	34 (97.14%)
Control group	35 (100%)	35 (100%)	35 (100%)	33 (94.28%)
χ^2				0.011
P				>0.999

Notes: *Indicates the time after surgery

Table 4. Comparison of surgical closure rate between two groups of small saphenous vein varices of lower extremity [$n = 15$, n/(%)]

Groups	At 0 time*	1 month*	3 month*	12 month*
Observation group	15 (100%)	15 (100%)	15 (100%)	14 (93.33%)
Control group	15 (100%)	15 (100%)	15 (100%)	13 (86.67%)
χ^2				0.028
P				0.999

Notes: *Indicates the time after surgery

3.2. Days of postoperative return to activity

In the GSV flexural surgery of the lower limbs, the average days of returning to normal activities were 2.71 ± 1.22 days in the observation group and 2.80 ± 1.28 days in the control group, and there was no significant difference between the two groups ($P > 0.05$), as shown in **Table 5**.

Table 5. Comparison of the days of return to normal activities after surgery between the two groups for varicose great saphenous veins of the lower extremities [$n = 35$, (Mean \pm SD)]

Groups	Cases	Days of return to activity after surgery
Observation group	35	2.71 ± 1.22
Control group	35	2.80 ± 1.28
<i>t</i>		0.289
<i>P</i>		0.773

The mean days of recovery after surgery for lower extremity saphenous vein flexion were 2.80 ± 1.08 days in the Halo laser group and 2.93 ± 0.79 days in the Biolitec laser group, with no statistical significance between the groups ($P > 0.05$), as shown in **Table 6**.

Table 6. Comparison of the days of return to normal activities after surgery between the two groups for small saphenous varicose veins of the lower extremities [$n = 15$, (Mean \pm SD)]

Groups	Cases	Days of return to activity after surgery
Observation group	15	2.80 ± 1.08
Control group	15	2.93 ± 0.79
<i>t</i>		0.384
<i>P</i>		0.704

3.3. VCSS score

Before operation, there was no significant difference in VCSS scores between the two groups of patients with lower extremity GSV varices ($t = 0.082$, $P > 0.05$), and there was no significant difference in VCSS scores between the two groups of patients with lower extremity SSV varices ($t = 1.269$, $P > 0.05$). Comparison between the observation group and the control group shows that the VCSS scores of both groups were significantly improved at 12 months after treatment, but there was no significant difference between the two groups (GSV varices $t = 0.548$, $P > 0.05$; SSV varicose $t = 0.770$, $P > 0.05$).

Comparison between the short-term (1 month, 3 months) and long-term (12 months) of the observation group show that the VCSS scores of the patients with GSV and SSV in the two groups were significantly lower than those before operation ($P < 0.05$) and slightly increased at 12 months after operation. Comparison of short-term (1 month, 3 months) and long-term (12 months) in the control group: the VCSS scores of patients with saphenous varicose veins in the GSV and SSV groups had the same phenomenon as those in the observation group.

There was no significant difference between the observation group and the control group ($P > 0.05$), and there was no statistical difference between the observation group and the control group ($P > 0.05$), and there was no statistical difference between the SSV group ($P > 0.05$), as shown in **Tables 7 and 8**.

Table 7. Surgical VCSS scores for varicose great saphenous veins of the lower extremities in both groups [$n = 35$, (Mean \pm SD)]

Groups	Pre-operation	1 month*	3 month*	12 month*	<i>t</i>	<i>P</i>
Observation group	10.65 \pm 5.28	1.62 \pm 0.77	1.91 \pm 0.78	4.14 \pm 1.53	7.008	<0.0001
Control group	10.23 \pm 4.88	1.69 \pm 0.76	2.00 \pm 0.84	4.25 \pm 1.52	6.917	<0.0001
<i>t</i>	0.353	0.313	0.442	0.313		
<i>P</i>	0.725	0.755	0.660	0.755		

Notes: *Indicates the time after surgery

Table 8. Surgical VCSS scores for varicose small saphenous veins of the lower extremities in both groups [$n = 15$, (Mean \pm SD)]

Groups	Pre-operation	1 month*	3 month*	12 month*	<i>t</i>	<i>P</i>
Observation group	11.13 \pm 4.15	1.73 \pm 0.88	2.00 \pm 0.84	4.33 \pm 1.63	5.899	<0.0001
Control group	11.53 \pm 4.08	1.80 \pm 0.77	2.06 \pm 0.88	4.40 \pm 1.50	6.346	<0.0001
<i>t</i>	0.266	0.220	0.211	0.116		
<i>P</i>	0.792	0.828	0.834	0.908		

Notes: *Indicates the time after surgery

3.4. Incidence of complications

There was no significant difference in the incidence of DVT, EHIT, surgical site ecchymosis, postoperative paresthesia (numbness), postoperative edema, burn, and superficial phlebitis between the two groups of patients with great saphenous vein varices and small saphenous vein varices ($P > 0.05$), as shown in **Table 9** and **10**.

Table 9. Comparison of the incidence of surgical complications between the two groups for varicose veins of the great saphenous vein of the lower extremities [$n = 35$, n/(%)]

Groups	DVT	EHIT	Ecchymosis at the surgical site	Postoperative paresthesia (numbness)	Postoperative edema	Burn	Superficial phlebitis
Observation group	0	0	5 (14.28%)	1 (2.86%)	1 (2.86%)	0	0
Control group	0	0	6 (17.14%)	2 (5.71%)	1 (2.86%)	0	0
χ^2							0.177
<i>P</i>							0.915

Table 10. Comparison of the incidence of surgical complications between the two groups for varicose veins of the small saphenous vein of the lower extremities [$n = 15$, n/(%)]

Groups	DVT	EHIT	Ecchymosis at the surgical site	Postoperative paresthesia (numbness)	Postoperative edema	Burn	Superficial phlebitis
Observation group	0	0	2 (13.33%)	1 (6.87%)	0	0	0
Control group	0	0	3 (20.00%)	1 (6.87%)	0	0	0
χ^2							0.050
<i>P</i>							0.823

4. Discussion

Chronic venous disease (CVD) of lower limbs is a syndrome of poor venous blood return and high venous pressure due to abnormal structure or function of veins, which leads to a series of symptoms and signs, mainly manifested as varicose, heavy, fatigue, distension and pain of saphenous veins of lower limbs ^[1-2, 8]. Edema, intermittent claudication, skin ulcer, and so on. In China, the prevalence of CVD was 8.89%, mainly for GSV varices, and 19% for SSA varices ^[10]. The treatment of varicose veins mainly includes surgical and non-surgical treatments. In the early stages of the disease, non-surgical procedures can be performed by paying attention to diet, changing lifestyle habits, and using elastic socks ^[11-12]. However, when the disease progresses to the advanced stage or more serious cases, it needs to be treated by surgery. There are various surgical methods, such as traditional high ligation, but with the development of endovenous treatment theories and techniques, the treatment of varicose veins of the lower extremities gradually develops to open, minimally invasive and non-invasive, and varicose vein dissection is developed successively, as well as the emerging endovenous ablation, EVLA, endovenous radiofrequency ablation (RFA), and so on ^[9, 13]. EVLA has the characteristics of less trauma, less psychological burden, faster recovery, less intraoperative blood loss, etc., and has been more and more widely used in the treatment of lower limb varicose veins ^[11-13].

In the previous study, the results show that the Biolitec and Halo laser devices have good clinical effectiveness in the treatment of the lower extremity great saphenous vein and small saphenous vein during EVLA treatment at the same power and LEED value, which is consistent with previous studies ^[12]. The closure rate was 100% in both groups at time 0 after surgery, and although the closure rate decreased over time, there was no significant difference between the two groups. The two groups also performed similarly in terms of the number of days back to activity after surgery and improvement in VCSS scores. In terms of safety, the incidence of adverse events was low and did not differ significantly between the two devices. This indicates that the safety of the two devices during treatment is comparable.

5. Limitations

However, this study also has some limitations. The sample size was relatively small and the follow-up time was limited, which may have some impact on the accuracy of the study results. Further studies with large sample size, multi-center and long-term follow-up are needed to evaluate the efficacy and safety of these two laser devices more comprehensively in the future.

6. Conclusions

In conclusion, both Biolitec and Halo laser devices were safe and effective for the treatment of lower extremity great and small saphenous veins at the same power and LEED, with no statistically significant differences in closure rates, days to return to normal activities after surgery, improvement in VCSS scores, and incidence of adverse events. Hence, clinicians can choose according to the patient's situation.

Disclosure statement

The author declares no conflict of interest.

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Experiences in the Application of Acupuncture in Stroke Rehabilitation with Integrated Traditional Chinese and Western Medicine

Qirui Qu*

College of Acupuncture, Moxibustion, Massage and Rehabilitation, Hunan University of Traditional Chinese Medicine, Changsha 410208, Hunan Province, China

*Corresponding author: Qirui Qu, 2360758395@qq.com

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Abstract: Stroke, characterized by high morbidity, disability, and mortality rates, has become one of the significant diseases seriously threatening human health. Patients often suffer from multiple functional disorders such as hemiplegia, dysphagia, and cognitive dysfunction. Although Western medicine rehabilitation treatment can promote functional recovery to a certain extent, it still has limitations. As an essential part of traditional medicine, acupuncture therapy in traditional Chinese medicine has gradually gained attention in the field of stroke rehabilitation due to its unique theoretical system and treatment methods. This article aims to comprehensively review the application of acupuncture in stroke rehabilitation with integrated traditional Chinese and Western medicine, providing a reference for further optimizing the stroke rehabilitation program that integrates traditional Chinese and Western medicine.

Keywords: Acupuncture; Integrated traditional Chinese and Western medicine; Stroke rehabilitation

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1. Introduction

Stroke, also known as cerebrovascular accident, refers to a group of diseases that cause brain tissue damage due to the sudden rupture of blood vessels in the brain or the blockage of blood flow to the brain, including ischemic stroke and hemorrhagic stroke. In recent years, with the intensifying aging of the population and lifestyle changes, the incidence of stroke has been increasing year by year. According to relevant data, from 2012 to 2019, the standardized prevalence of stroke among people aged 40 and over in China increased, from 1.89% in 2012 to 2.58% in 2019. As of 2019, the number of people aged 40 and over in China who have had or are currently suffering from stroke has reached approximately 17.04 million ^[1]. Western medicine has made significant progress in the treatment of acute stroke, such as thrombolysis, thrombectomy, antiplatelet aggregation, and neuroprotective treatments, playing a vital role in saving lives and reducing brain damage. However, in the rehabilitation phase

of stroke, Western physical and occupational therapies mainly focus on improving limb function through passive or active exercise training. These methods have limitations in addressing complex neurological impairments and regulating overall bodily functions. Traditional Chinese medicine has a long history of understanding stroke, with relevant records dating back to the “Huangdi Neijing” (Yellow Emperor’s Classic of Internal Medicine). According to traditional Chinese medicine, the occurrence of stroke is mainly related to factors such as wind, fire, phlegm, stagnation, and deficiency, and the key pathogenesis is the disturbance of qi and blood, which ascends and attacks the brain. The “Huangdi Neijing” dedicates significant attention to acupuncture therapy. As a typical external treatment method in traditional Chinese medicine, acupuncture therapy differs from internal treatments like decoctions. Internal treatments rely on the properties of medicinal herbs to “correct imbalances with imbalances” and regulate the yin-yang balance of the internal organs ^[2]. Acupuncture therapy, on the other hand, involves stimulating acupuncture points on the body’s surface tissues. Its principle is to mobilize the body’s own qi, stimulate acupuncture points, activate the flow of qi, achieve the dredging of meridians, and regulate qi and blood, thereby achieving the goal of treating diseases. This demonstrates the unique treatment ideas and methods of external therapies in traditional Chinese medicine ^[3]. In recent years, increasing clinical studies have shown that acupuncture has unique advantages in stroke rehabilitation, effectively improving patients’ limb motor function, swallowing function, and cognitive function.

2. The theoretical basis of acupuncture in stroke rehabilitation

2.1. Theory of meridians and channels in traditional Chinese medicine

In the theory of traditional Chinese medicine, “qi” is an important concept, which originates from ancient people’s observation of the universe, heaven and earth, and human life phenomena. After summarizing, the ancients used “qi” to summarize the functions of the viscera, meridians, and channels. Qi plays a role in human life activities, participates in promoting human body operations, and is also related to the coordination of the internal organs, meridians, and channels. It is the key point for traditional Chinese medicine to understand human physiology and pathology ^[4]. The theory of meridians and channels in traditional Chinese medicine believes that the human meridian system is a complex network composed of meridians and collateral meridians, which connects the internal organs, and external limbs, communicates the exterior and interior, runs through the upper and lower parts, and connects various parts of the human body into an organic whole. The meridians and channels are not only the passageways for the circulation of qi and blood but also an important system for the body to transmit information and regulate functions. When a disease occurs in the human body, the qi and blood circulation and regulatory functions of the meridians and channels will be disordered. Acupuncture stimulates corresponding acupoints to stimulate the regulatory effect of the meridians and channels, so that the qi and blood are smooth, and the viscera functions are restored to balance, thereby achieving the purpose of treating diseases. For stroke patients, due to the disturbance of qi and blood in the brain, which leads to the blockage of meridians and channels, acupuncture can select acupoints on the head, limbs, and other parts to dredge the meridians and channels, promote qi and blood circulation, and improve brain and limb functions.

2.2. Modern neuroanatomy and physiology theory

In stroke rehabilitation, acupuncture can stimulate acupoints to stimulate qi, regulate qi and blood circulation, and help restore nervous system function. It is an important part of integrated traditional Chinese and Western medicine

rehabilitation ^[5]. From the perspective of modern neuroanatomy and physiology, acupuncture at acupoints can affect the function of the central nervous system through neural transmission pathways. On the one hand, the neural impulses generated by acupuncture stimulation of acupoints can be transmitted along the peripheral nerves to the spinal cord and brain, activating multiple regions of the cerebral cortex and promoting the release of neurotransmitters such as dopamine and 5-hydroxytryptamine. These neurotransmitters play an important role in regulating movement, sensation, and emotion. On the other hand, acupuncture can also regulate neural plasticity, promote the repair and regeneration of damaged nerve cells, induce the proliferation and differentiation of neural stem cells, and form new synaptic connections, thereby improving the neurological function of stroke patients.

3. Acupuncture treatment methods in stroke rehabilitation

3.1. Ordinary acupuncture treatment

Ordinary acupuncture is the most commonly used acupuncture treatment method. Based on the principles of syndrome differentiation and treatment in traditional Chinese medicine, syndrome differentiation is performed according to the patient's symptoms, signs, tongue manifestations, and pulse conditions, such as liver yang hyperactivity type, wind-phlegm obstruction type, phlegm-heat fu-organ excess type, qi deficiency and blood stasis type, and yin deficiency and wind movement type. Then select the corresponding acupoints for acupuncture. Commonly used head acupoints include Baihui, Shenting, Fengchi, and Shuaigu, which can directly stimulate the cranial nerves and regulate brain function; limb acupoints such as Jianyu, Quchi, Waiguan, Hegu, Huantiao, Zusanli, Yanglingquan, and Sanyinjiao can promote the qi and blood circulation of the limbs and improve limb movement function. During acupuncture operation, appropriate acupuncture techniques such as lifting and thrusting, twisting, and turning are adopted according to the different characteristics of acupoints and the severity of the disease.

3.2. Electro-acupuncture treatment

Electro-acupuncture is based on ordinary acupuncture, where the filiform needle is connected to an electro-acupuncture device, and different frequencies, waveforms, and intensities of current are output to continuously stimulate the acupoints. The advantage of electro-acupuncture is that it can enhance the stimulation intensity and duration of acupuncture, improving the treatment effect. Different frequencies of electro-acupuncture stimulation have different effects. Low-frequency electro-acupuncture (1–2 Hz) can promote neuromuscular excitation and increase muscle tension; high-frequency electro-acupuncture (100 Hz) has a good analgesic effect and promotes blood circulation. In stroke rehabilitation treatment, the appropriate frequency and waveform are often selected according to the patient's specific situation. For example, for patients with hemiplegia, the shu-mi wave can be used on limb acupoints to promote muscle contraction and nerve function recovery.

3.3. Special acupuncture therapy

Special acupuncture therapy refers to some acupuncture techniques with unique operation methods or treatment characteristics developed based on traditional acupuncture. Special acupuncture therapy includes fire needle, needle knife, penetration needle, etc. ^[6]. Fire needle provides warm stimulation, needle knife performs tissue dissection, and penetration needle penetrates spasmodic tissue, all of which can stimulate meridians and acupoints, promote the rapid emergence of meridian and acupoint effects, enhance the sensation of acupuncture, and thus improve clinical efficacy.

3.3.1. Fire needle therapy

In acupuncture therapy, fire needle therapy belongs to a special type, which has evolved from filiform needles. It combines the advantages of moxibustion and acupuncture, which can not only exert the warming effect of moxibustion but also produce the mechanical stimulation of acupuncture. The fire needle transmits the heat carried by the needle body through meridians and collateral meridians, which can directly stimulate the yang qi in the body, promote qi and blood circulation, allow warm stimulation to reach the diseased area, and also improve the function of internal organs^[7]. Fire needle is a method of puncturing acupoints quickly after burning a specially made needle red. It has the effect of warming and dredging meridians. In stroke rehabilitation, it can deal with limb muscle atrophy and joint contracture, using warm stimulation to promote qi and blood, strengthen muscle strength, and relieve spasms.

3.3.2. Needle knife therapy

Needle knife therapy combines the concepts of traditional Chinese acupuncture and Western surgical operations. Stroke causes muscle spasms and soft tissue adhesions in patients, affecting limb movement function. The small blade at the front end of the needle knife can precisely cut and peel the diseased area. For example, if a patient has upper limb flexor spasms due to stroke, and the muscles, tendons, and surrounding tissues are adherent, making it difficult to extend the upper limbs, the needle knife can penetrate the adhesion, release abnormal connections, restore the muscular state, improve upper limb movements, help patients complete grasping and stretching actions, and enhance self-care ability.

3.3.3. Penetration needle therapy

Penetration needle therapy uses a specially made long needle to stimulate deep meridians, acupoints, or diseased tissues through the skin and muscles. This therapy stimulates deep acupoints, stimulates the deep meridians and qi, and regulates neural transmission. Penetrating needle stimulation of lower limb acupoints activates nerve reflex arcs, promotes nerve function repair and remodeling, enhances nerve control over muscles, improves lower limb motor function, helps patients regain walking and standing ability, and improves quality of life.

4. Clinical effects of acupuncture in stroke rehabilitation

4.1. Impact on limb motor function

Acupuncture has multiple mechanisms in promoting the recovery of limb motor function in stroke patients. By regulating nerve function, stimulating the motor area of the cerebral cortex, promoting neuroplastic changes, and thus rebuilding or compensating for damaged motor nerve pathways; in promoting muscle contraction, it can improve the nutritional supply of limb muscles, prevent muscle atrophy, and enhance muscle strength and joint mobility; it can also improve blood circulation, creating good conditions for recovery. Xie Mingyun randomly divided 72 patients with limb dysfunction after a stroke into a control group (conventional treatment, ordinary acupuncture combined with rehabilitation exercise) and an experimental group (ordinary acupuncture combined with temporal three-needle and rehabilitation exercise based on conventional treatment)^[8]. After treatment, it was found that the experimental group had lower scores for traditional Chinese medicine symptoms and hemorheological indicators, higher FuglMeyer scores, and a higher proportion of muscle strength grades V-VI compared to the control group, with a lower proportion of grades I-IV. This shows that acupuncture therapy is beneficial for improving patients' muscle strength and limb function.

4.2. Impact on swallowing function

Swallowing disorder after stroke is one of the common complications, which seriously affects patients' nutritional intake and quality of life, and can even lead to complications such as aspiration and lung infection. Acupuncture has unique advantages in treating swallowing disorders. In traditional Chinese medicine, swallowing disorders are believed to be related to poor circulation of qi and blood in the throat meridians. By needling acupoints such as Lianquan, Fengchi, Renying, and Yifeng, acupuncture can dredge the throat meridians, regulate qi and blood circulation, and improve swallowing function. Bo Huali selected 60 patients with swallowing dysfunction after a stroke and randomly divided them into two groups^[9]. The control group only received rehabilitation training, while the observation group received acupuncture treatment based on the control group's rehabilitation training. After treatment, it was observed that the observation group was significantly better than the control group in terms of total treatment efficiency and swallowing function score. This shows that rehabilitation training combined with acupuncture treatment can better meet the treatment needs of patients with swallowing dysfunction after stroke, has a positive effect on improving patients' swallowing function, and has certain clinical promotion significance.

4.3. Impact on cognitive function

Cognitive dysfunction after a stroke includes memory loss, inability to concentrate, executive dysfunction, etc., which seriously affects patients' daily living abilities and rehabilitation effects. Acupuncture has a certain therapeutic effect on cognitive dysfunction after stroke by regulating the level of neurotransmitters in the brain, improving cerebral blood circulation, and promoting the repair of nerve cells. Chen Honglin and Guan Fang explored the effects of acupuncture combined with cognitive rehabilitation training on mild cognitive dysfunction after stroke^[10]. They selected 110 patients and randomly divided them into a control group and an observation group, all receiving conventional treatment. The control group received cognitive rehabilitation training, while the observation group received additional acupuncture treatment. The results showed that after treatment, the observation group had higher MMSE and MoCA scores and nitric oxide levels than the control group, and lower intracranial artery-related resistance index and endothelin-1 levels, with statistically significant differences ($P<0.05$). This shows that acupuncture combined with cognitive rehabilitation training has significant clinical effects, can improve cerebrovascular indicators, and enhance vascular endothelial function.

4.4. Impact on other functional disorders

Acupuncture has a positive significance in improving multiple functional disorders in stroke patients. Apart from limb movement, swallowing, and cognitive functions, it also has certain effects on speech, balance, and bowel and bladder functions. In terms of speech function, needling acupoints such as Tongli, Lianquan, Jinjin, and Yuye can promote the recovery of speech function. For balance function, acupuncture at acupoints such as Zusanli, Sanyinjiao, and Xuanzhong can improve patients' balance ability and reduce the risk of falls. In terms of bowel and bladder function, acupuncture at acupoints such as Zhongji, Guanyuan, Qihai, and Sanyinjiao can regulate bladder function and effectively improve symptoms such as urinary incontinence or retention in stroke patients. This shows that acupuncture plays a non-negligible role in the rehabilitation of multiple functional disorders in stroke patients and provides an effective way for patients' functional recovery.

5. Conclusion and prospects

As an important means of traditional Chinese medicine treatment, acupuncture has important application value

in the rehabilitation of stroke combining traditional Chinese and Western medicine. From the theoretical basis, the meridians and collaterals theory of traditional Chinese medicine and modern neuroanatomy and physiology theories provide a scientific basis for the treatment of stroke with acupuncture. In terms of treatment methods, various acupuncture techniques such as ordinary acupuncture, electroacupuncture, and special acupuncture therapies can be selected and applied according to the specific conditions of patients. Clinical studies have shown that acupuncture has significant effects in improving limb motor function, swallowing function, cognitive function, and other aspects of stroke patients, and also has a certain improvement effect on other functional disorders. Combining acupuncture with Western medicine rehabilitation treatment to form an integrated traditional Chinese and Western medicine stroke rehabilitation model can fully leverage the advantages of both traditional Chinese and Western medicine, improve the rehabilitation effect of stroke patients, and enhance their quality of life. Although acupuncture has achieved certain results in the rehabilitation of stroke combining traditional Chinese and Western medicine, there are still some problems that need further resolution. In clinical application, the acupoint prescriptions and acupuncture techniques for the treatment of stroke with acupuncture are not yet fully standardized, and there are large differences in treatment plans among different doctors, which may affect the stability and comparability of treatment effects. In the future, multi-center, large-sample clinical studies are needed to optimize acupuncture treatment plans and develop unified standards for acupoint prescriptions and acupuncture techniques.

Disclosure statement

The author declares no conflict of interest.

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Trend of Global Neck Pain Disease Burden from 1990 to 2021

Weigang Liu^{1,2}, Qian Wu^{1,3}, Heqing Tang^{1,2*}

¹The First Clinical Medical College of Three Gorges University, Yichang 443003, Hubei Province, China

²Department of Pain, Yichang City Central People's Hospital, Yichang 443003, Hubei Province, China

³Department of Diagnostic Cardiology, Yichang Central People's Hospital, Yichang 443003, Hubei Province, China

*Corresponding author: Heqing Tang, lwgtjmu001@outlook.com

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Abstract: *Objective:* This study aims to provide an accurate quantitative analysis of the global burden of neck pain, offering a scientific basis for the formulation of effective prevention and control strategies. *Methods:* Data related to the global burden of neck pain from 1990 to 2021 were collected from the Global Burden of Disease Study (GBD 2021) database. Descriptive analyses were conducted using indicators such as incidence, incidence rate, prevalence, prevalence rate, years lived with disability (YLDs), and YLDs rate. *Results:* From 1990 to 2021, the total number of cases of neck pain worldwide increased from 24.9 million to 43.26 million, an overall increase of 73.82%; the total number of prevalent cases rose from approximately 114 million to about 206 million, representing an overall increase of 79.78%. However, the age-standardized incidence rate and prevalence rate showed relatively small increases of 1.18% and 0.26%, respectively. The total YLDs increased from about 114 million in 1990 to approximately 204 million in 2021, marking an overall increase of 78.42%. The YLD rate per 100,000 population rose from 214.53 in 1990 to 258.71 in 2021, an increase of about 20.59%. The age-standardized YLD rate only saw a slight increase of 0.14%. The incidence rate, prevalence rate, and YLDs rate of neck pain were all higher in females than in males, with a more significant increase observed in females. In 2021, the incidence rate for females approached 620 per 100,000, the prevalence rate was close to 3,200 per 100,000, and the YLDs rate was nearly 290 per 100,000; whereas for males, the incidence rate was about 480 per 100,000, the prevalence rate was around 2,600 per 100,000, and the YLDs rate was nearly 230 per 100,000. *Conclusion:* This study reveals a significant increase in the global burden of neck pain from 1990 to 2021, particularly in the total number of cases. Although the age-standardized incidence and prevalence rates increased relatively modestly, the notable rise in total numbers indicates that neck pain continues to have an escalating impact on global health. The higher incidence, prevalence, and YLDs rates in females compared to males suggest a need for more targeted health interventions and management strategies addressing gender differences. Future research should further explore the specific risk factors for neck pain and their relative contributions, providing a scientific basis for developing effective prevention and control strategies.

Keywords: Neck pain; Disease burden; Attributable risk factors; Global

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1. Introduction

Neck pain (NP) is a prevalent health issue worldwide, profoundly impacting individuals' quality of life, work efficiency, and socio-economics ^[1]. As a common musculoskeletal disorder, neck pain can lead to symptoms such as neck discomfort, stiffness, and restricted movement, and may also trigger a range of complications including headaches, shoulder pain, and arm numbness, severely affecting daily activities and occupational functions ^[2]. With the rapid development of global socio-economics and significant lifestyle changes, the incidence and burden of neck pain have exhibited complex trends over the past few decades. Modern lifestyles, such as prolonged sitting, lack of physical activity, poor posture, and extensive use of electronic devices, are considered significant factors contributing to the rising incidence of neck pain. Additionally, occupational factors, including maintaining fixed postures for long periods, repetitive neck movements, and work-related stress, may exacerbate the occurrence and progression of neck pain ^[3-4]. Psychological factors, such as stress, anxiety, and depression, are also closely associated with the onset of neck pain. Despite significant differences in the incidence and burden of neck pain across various regions and populations, neck pain has overall become a global public health issue that necessitates in-depth research and effective interventions ^[5]. This study aims to systematically analyze the trends in the global burden of neck pain from 1990 to 2021 using the Global Burden of Disease (GBD) database and explore its main attributable risk factors, providing a scientific basis for developing effective prevention and control strategies.

2. Materials and methods

2.1. Data

The data for this study comes from the latest release of the Global Burden of Diseases (GBD2021) database. This database comprehensively records the epidemiological data on global neck pain from 1990 to 2021, covering disease burden indicators such as incidence and prevalence by age, sex, and regional distribution. GBD2021 employs a standardized and comparable methodology to analyze and estimate the disease burden of 369 diseases or injuries across 204 countries (regions) globally, and systematically reviews the attributable disease burden of 88 risk factors, making it the most comprehensive database available worldwide ^[1]. This study filtered the GBD2021 data, selecting the region as “Global”, the disease as “Neck pain”, the years covering all years from 1990 to 2021, age set to “Select all”, and sex including “Male”, “Female”, and “Both.” The definition of neck pain is based on the International Classification of Diseases, 10th edition (ICD-10) standards.

2.2. Indicator selection

This study employs the number of new cases, number of deaths, years lost to ill health, incidence rate, prevalence rate, years lost to ill health rate, and age-standardized rates (ASR) of incidence, prevalence, and years lost to ill health to assess the global trends and disease burden of neck pain. All of the above data can be directly obtained from the GBD official website (<https://www.healthdata.org/gbd>).

2.3. Statistical methods

All statistical analyses were performed using R software (version 4.2.1) and SAS software (version 9.4) to ensure the accuracy and reliability of the analyses. The significance level was set at $P < 0.05$ to evaluate the statistical significance of the results.

3. Results

3.1. Incidence of neck pain in the global population from 1990–2021

Table 1 shows that the total incidence and incidence rate of neck pain globally experienced significant growth from 1990 to 2021. The total number of cases increased from 24.9 million in 1990 to 43.26 million in 2021, an overall increase of 73.82%. Correspondingly, the standardized incidence rate (per 100,000 population) slightly increased from 513.21 in 1990 to 519.28 in 2021, a growth of only 1.18%. Specifically, the incidence rate per 100,000 population rose from 466.91 in 1990 to 545.89 in 2021, an increase of approximately 17.48%. The age-standardized incidence rate fluctuated slightly during this period, indicating that although the total number of neck pain cases increased, the growth was not significant when considering changes in population structure. This suggests that despite the rapid growth and aging of the global population over the past 30 years, the incidence of neck pain per 100,000 population has not changed significantly. However, after 2000, the incidence rate and number of cases of neck pain increased significantly, possibly related to changes in modern lifestyles, office environments, and occupational habits. This trend indicates that neck pain remains an important public health issue, necessitating strengthened prevention and management strategies.

Table 1. Incidence of neck pain in the global population from 1990 to 2021

Years	Incidence number	Incidence rate (Per 100,000)	Age-standardized incidence rate (Per 100,000)
1990	24903378.60(19628380.36,30674274.35)	466.91(368.01,575.11)	513.21(404.32,630.08)
1991	25635861.91(20212707.43,31625825.87)	473.29(373.17,583.88)	517.75(407.60,636.30)
1992	26315246.94(20754009.71,32521410.59)	478.70(377.54,591.60)	521.10(409.98,640.86)
1993	26944333.47(21257457.66,33361210.57)	483.27(381.27,598.36)	523.36(411.55,643.30)
1994	27522098.67(21718438.82,34119537.43)	487.08(384.37,603.84)	524.67(412.41,644.51)
1995	28060577.86(22145010.49,34834397.38)	490.22(386.88,608.56)	525.08(412.61,644.60)
1996	28487498.23(22498874.88,35382737.36)	491.30(388.02,610.22)	523.42(411.39,641.60)
1997	28772776.44(22721199.74,35720646.66)	489.91(386.87,608.21)	519.24(408.15,636.11)
1998	28990944.65(22880039.10,36014127.93)	487.42(384.68,605.49)	513.87(403.92,629.20)
1999	29217865.29(23030277.96,36244631.91)	485.11(382.38,601.78)	508.68(399.41,622.49)
2000	29539466.77(23261370.25,36564511.91)	484.35(381.41,599.54)	504.95(396.08,617.51)
2001	29923791.79(23573709.62,37007945.17)	484.50(381.69,599.20)	502.16(393.84,614.16)
2002	30299439.42(23871680.44,37443369.21)	484.37(381.62,598.58)	499.09(391.37,610.42)
2003	30696020.34(24171548.75,37894616.51)	484.46(381.49,598.07)	496.26(389.08,606.95)
2004	31145567.89(24501367.05,38420044.91)	485.26(381.74,598.59)	494.18(387.37,604.40)
2005	31678989.04(24889147.08,39057091.00)	487.19(382.77,600.66)	493.30(386.56,603.36)
2006	32388142.44(25416170.49,39878636.60)	491.57(385.75,605.26)	495.03(388.51,605.64)
2007	33274425.15(26139347.55,40924228.11)	498.32(391.46,612.88)	499.32(392.21,610.84)
2008	34243200.76(26935524.39,42144776.32)	505.92(397.95,622.66)	504.57(396.27,616.71)
2009	35177129.56(27702165.95,43310498.33)	512.71(403.76,631.25)	509.12(399.79,621.75)

Table 1 (Continued)

Years	Incidence number	Incidence rate (Per 100,000)	Age-standardized incidence rate (Per 100,000)
2010	35945137.87(28340591.34,44238018.08)	517.14(407.73,636.45)	511.24(401.45,623.95)
2011	36606377.13(28862575.65,44988468.91)	520.14(410.11,639.24)	512.00(402.15,624.83)
2012	37309535.73(29366425.00,45813842.20)	523.54(412.08,642.88)	513.29(403.26,626.34)
2013	38025674.76(29875671.14,46656784.74)	526.95(414.01,646.55)	514.74(404.49,628.02)
2014	38728606.73(30376610.99,47476920.22)	530.08(415.77,649.82)	515.99(405.55,629.41)
2015	39386652.42(30854091.57,48257675.06)	532.51(417.15,652.45)	516.63(406.09,630.12)
2016	40038531.38(31378804.31,49020554.92)	534.80(419.13,654.78)	517.15(406.47,630.70)
2017	40723636.67(31932737.13,49827019.39)	537.57(421.52,657.73)	518.01(407.07,631.73)
2018	41414971.47(32498736.42,50654233.51)	540.52(424.15,661.11)	518.83(407.63,632.73)
2019	42085880.25(33018902.57,51434948.19)	543.37(426.31,664.08)	519.26(407.90,633.22)
2020	42701340.09(33484968.66,52132968.55)	545.89(428.07,666.46)	519.24(407.93,633.21)
2021	43286060.82(33941593.57,52883959.03)	548.53(430.11,670.15)	519.28(407.85,633.38)
Percentage change (%)	73.82(64.11,82.75)	17.48(10.92,23.52)	1.18(0.07,2.39)

3.2. Prevalence of neck pain globally (1990–2021)

Table 2 shows that the total number of people and the prevalence rate of neck pain worldwide increased significantly from 1990 to 2021. The total number of cases rose from approximately 114 million in 1990 to about 206 million in 2021, an overall increase of 79.78%. Correspondingly, the standardized prevalence rate (per 100,000) slightly increased from 2436.71 in 1990 to 2443.02 in 2021, a growth of just 0.26%. Specifically, the prevalence rate per 100,000 people increased from 2148.66 in 1990 to 2610.83 in 2021, an increase of roughly 21.51%. The age-standardized prevalence rate fluctuated slightly during this period, indicating that despite population aging and growth, the adjusted prevalence rate did not rise significantly. This means that the actual prevalence of neck pain globally has not increased markedly due to population changes. Overall, despite a significant increase in the total population base, considering population structure and age factors, the actual prevalence rate of neck pain has only slightly increased. This indicates that neck pain remains a long-term health issue globally, but its expansion rate is limited.

Table 2. Prevalence of neck pain globally (1990–2021)

Years	Prevalence number	Prevalence rate (Per 100,000)	Age-standardized prevalence rate (Per 100,000)
1990	114601451.02(88840737.56,141520154.71)	2148.66(1665.67,2653.36)	2436.71(1912.98,2992.64)
1991	118054621.98(91492834.61,145987445.71)	2179.53(1689.15,2695.23)	2458.99(1930.68,3020.59)
1992	121288442.97(94045524.00,150095385.63)	2206.36(1710.79,2730.39)	2475.34(1943.74,3040.28)
1993	124280383.81(96515571.07,153879956.45)	2229.06(1731.08,2759.95)	2486.22(1952.52,3053.72)
1994	127044169.22(98721900.64,157440067.84)	2248.39(1747.15,2786.32)	2492.12(1957.33,3060.91)

Table 2 (Continued)

Years	Prevalence number	Prevalence rate (Per 100,000)	Age-standardized prevalence rate (Per 100,000)
1995	129588747.41(100720997.80,160741356.10)	2263.93(1759.61,2808.17)	2493.54(1958.51,3063.83)
1996	131635555.64(102599121.00,162990901.38)	2270.21(1769.44,2810.97)	2484.49(1951.55,3049.04)
1997	133020364.22(103732025.46,164290911.70)	2264.92(1766.23,2797.36)	2462.97(1932.32,3019.06)
1998	134087134.11(104490100.05,165180830.06)	2254.37(1756.76,2777.14)	2435.66(1909.83,2981.91)
1999	135208008.88(105113511.31,166307499.80)	2244.90(1745.24,2761.26)	2409.23(1887.75,2949.73)
2000	136773983.87(106180334.05,168238985.32)	2242.65(1741.01,2758.57)	2389.93(1870.90,2926.45)
2001	138635564.47(107846885.62,170531786.59)	2244.67(1746.17,2761.11)	2374.97(1861.11,2910.14)
2002	140433499.08(109374634.27,172802733.05)	2245.00(1748.49,2762.47)	2358.36(1850.15,2891.56)
2003	142322634.66(110942255.59,175187826.93)	2246.21(1750.95,2764.91)	2342.81(1839.70,2874.18)
2004	144479899.66(112701303.22,177887264.50)	2251.04(1755.92,2771.53)	2331.08(1831.90,2861.12)
2005	147064380.42(114794324.35,181096789.10)	2261.71(1765.43,2785.10)	2325.44(1828.70,2854.01)
2006	150491564.14(117389664.06,185335558.42)	2284.08(1781.68,2812.92)	2332.11(1835.49,2858.07)
2007	154759222.16(120910881.36,190627225.01)	2317.66(1810.75,2854.82)	2350.44(1851.40,2876.18)
2008	159441312.98(124776816.47,196355257.32)	2355.62(1843.48,2901.00)	2373.21(1868.31,2903.19)
2009	164016159.61(128552701.10,201906387.58)	2390.54(1873.66,2942.79)	2392.98(1882.78,2933.64)
2010	167871040.92(131709376.74,206523575.27)	2415.15(1894.89,2971.24)	2401.80(1889.83,2949.63)
2011	171291363.82(134395805.86,210472494.30)	2433.86(1909.62,2990.58)	2404.96(1892.85,2953.25)
2012	174935366.65(137265393.75,214678265.08)	2454.77(1926.17,3012.47)	2411.07(1898.23,2960.39)
2013	178675444.48(140181148.95,219026015.80)	2476.03(1942.58,3035.19)	2418.15(1904.23,2968.70)
2014	182350927.59(143061421.79,223349000.94)	2495.86(1958.10,3057.01)	2424.36(1909.40,2975.93)
2015	185822944.52(145959568.74,227522797.57)	2512.34(1973.38,3076.12)	2427.56(1912.04,2979.83)
2016	189264465.01(148779510.09,231733149.34)	2528.04(1987.27,3095.30)	2430.51(1914.25,2984.45)
2017	192876155.40(151502319.90,236160265.45)	2546.03(1999.88,3117.40)	2435.40(1917.83,2991.57)
2018	196489260.45(154515966.62,240729684.99)	2564.46(2016.65,3141.85)	2440.09(1921.33,2998.32)
2019	199938828.23(157213591.51,245022499.96)	2581.41(2029.79,3163.49)	2442.50(1923.36,3002.24)
2020	203045202.61(159494966.19,248947822.74)	2595.70(2038.96,3182.51)	2442.22(1923.24,3000.91)
2021	206029628.55(161756682.55,252863254.40)	2610.83(2049.80,3204.31)	2443.02(1923.04,3002.33)
Percentage change (%)	79.78(71.45,88.55)	21.51(15.88,27.44)	0.26(-1.35,1.87)

3.3. Years lived with disability due to neck pain in the global population from 1990 to 2021

Table 3 shows the trend of YLDs (Years Lived with Disability) due to neck pain globally from 1990 to 2021 based on the GBD database analysis. The chart indicates that both the total number of YLDs and the prevalence

of neck pain have increased significantly over this period. The total YLDs rose from approximately 114 million in 1990 to about 204 million in 2021, an overall increase of 78.42%. Correspondingly, the adjusted YLD rate (per 100,000 people) slightly increased from 214.53 in 1990 to 258.71 in 2021, a growth of about 20.59%. Specifically, the YLD rate per 100,000 population rose from 214.53 in 1990 to 258.71 in 2021, indicating a significant increase in YLDs caused by neck pain globally. This suggests that the burden of neck pain on global health has been intensifying year by year. After 2000, the global YLDs due to neck pain increased significantly. Factors such as globalization and industrialization may have led to lifestyle changes like prolonged sitting and high work pressure, further exacerbating these conditions. The age-standardized YLD rate (per 100,000 people) slightly increased from 241.96 in 1990 to 242.10 in 2021, with a growth of only 0.14%, indicating that the actual burden of neck pain has not changed much when considering population structure changes.

Table 3. Health loss years due to neck pain in the global population from 1990 to 2021

Years	YLDs number	YLDs rate (Per 100,000)	Age-standardized YLDs rate (Per 100,000)
1990	11442356.21(7608943.12,16334312.96)	214.53(142.66,306.25)	241.96(162.05,343.53)
1991	11786408.05(7837530.85,16843804.90)	217.60(144.70,310.97)	244.19(163.58,347.06)
1992	12108253.11(8046828.93,17338392.27)	220.26(146.38,315.40)	245.83(164.69,349.69)
1993	12407690.44(8256388.98,17801984.30)	222.54(148.08,319.29)	246.95(165.54,351.36)
1994	12683073.86(8446181.55,18242001.56)	224.46(149.48,322.84)	247.56(166.07,353.20)
1995	12936394.91(8612985.41,18631810.98)	226.00(150.47,325.50)	247.71(166.33,353.59)
1996	13139483.44(8760679.33,18906460.16)	226.61(151.09,326.06)	246.82(165.35,351.61)
1997	13276019.35(8856502.28,19079237.49)	226.05(150.80,324.86)	244.68(163.88,348.26)
1998	13381949.05(8932151.22,19198017.98)	224.99(150.17,322.77)	241.98(162.34,344.42)
1999	13492490.26(9012695.84,19287357.37)	224.02(149.64,320.23)	239.36(160.56,339.97)
2000	13647443.75(9125622.24,19482447.96)	223.77(149.63,319.45)	237.45(159.59,337.15)
2001	13832848.42(9251768.90,19720985.78)	223.97(149.80,319.31)	235.99(158.62,335.04)
2002	14011608.18(9382829.91,19979325.92)	223.99(150.00,319.39)	234.36(157.46,332.71)
2003	14200966.25(9515626.15,20253033.13)	224.13(150.18,319.64)	232.87(156.17,330.46)
2004	14416024.35(9665430.07,20560614.09)	224.61(150.59,320.34)	231.74(155.56,328.90)
2005	14673762.17(9835301.98,20957418.85)	225.67(151.26,322.31)	231.21(155.27,328.47)
2006	15012643.81(10059596.94,21440239.89)	227.85(152.68,325.41)	231.87(155.63,329.25)
2007	15437234.32(10343912.88,22092019.26)	231.19(154.91,330.85)	233.73(156.94,331.91)
2008	15902915.06(10640886.08,22717146.05)	234.95(157.21,335.63)	236.02(158.47,334.27)
2009	16355182.10(10935127.05,23337743.18)	238.38(159.38,340.15)	237.99(159.71,337.31)
2010	16737049.95(11178192.58,23878612.22)	240.79(160.82,343.54)	238.89(160.23,338.83)
2011	17072344.57(11412593.79,24334193.78)	242.58(162.16,345.76)	239.19(160.42,338.90)
2012	17430329.44(11659759.97,24818078.36)	244.59(163.62,348.26)	239.79(160.74,339.61)
2013	17797393.85(11903678.46,25324949.52)	246.63(164.96,350.94)	240.49(161.07,340.48)

Table 3 (Continued)

Years	YLDs number	YLDs rate (Per 100,000)	Age-standardized YLDs rate (Per 100,000)
2014	18157592.47(12121326.70,25822220.50)	248.53(165.91,353.43)	241.10(161.54,341.11)
2015	18495550.57(12364371.80,26289679.65)	250.06(167.17,355.44)	241.39(161.93,341.71)
2016	18831781.92(12584522.64,26727571.95)	251.54(168.09,357.00)	241.67(162.00,341.91)
2017	19183617.16(12812703.92,27259736.74)	253.23(169.13,359.84)	242.15(162.37,343.25)
2018	19534346.50(13027129.80,27702018.62)	254.95(170.02,361.55)	242.59(162.59,343.43)
2019	19867146.71(13255260.69,28174781.48)	256.50(171.14,363.76)	242.79(162.77,344.03)
2020	20145432.68(13446255.74,28503224.97)	257.54(171.90,364.38)	242.47(162.71,343.03)
2021	20415496.55(13638705.32,28856642.59)	258.71(172.83,365.67)	242.30(162.60,342.76)
Percentage change (%)	78.42(69.94,87.21)	20.59(14.86,26.53)	0.14(-1.52,1.77)

3.4. Changes in global neck pain by gender from 1990 to 2021

Figure 1 shows that the incidence of neck pain in both genders has increased from 1990 to 2021, with the incidence rate in females consistently higher than in males. Overall, the incidence rate of neck pain in females has been continuously rising since 1990, reaching nearly 620 per 100,000 in 2021. In contrast, the incidence rate in males is relatively lower but also shows an upward trend, approaching 480 per 100,000 in 2021. After age standardization, the incidence rate decreases, but females still show a significantly higher rate than males, and both genders exhibit an increasing trend. The prevalence rate of neck pain in both genders also shows an upward trend within the same period. The prevalence rate in females rose to 3,200 per 100,000 in 2021, while the prevalence rate in males approached 2,600 per 100,000 in 2021. After age standardization, the prevalence rate decreases, but the gender disparity remains. The YLDs rate for both genders also shows that females have a significantly higher rate than males. By 2021, the YLDs rate in females approached 290 per 100,000, while the rate in males was close to 230 per 100,000. After age standardization, the YLDs rate in females remains higher than in males, and both show an increasing trend. Overall, from 1990 to 2021, the global incidence, prevalence, and YLDs rates of neck pain have shown a significant upward trend across genders. Females exhibit higher rates in all three metrics compared to males, with a more notable increase. Particularly in terms of incidence and prevalence, females show a larger disparity compared to males. These trends underscore the significance of neck pain as a public health issue globally and suggest the need for more targeted gender-specific health interventions and management strategies.

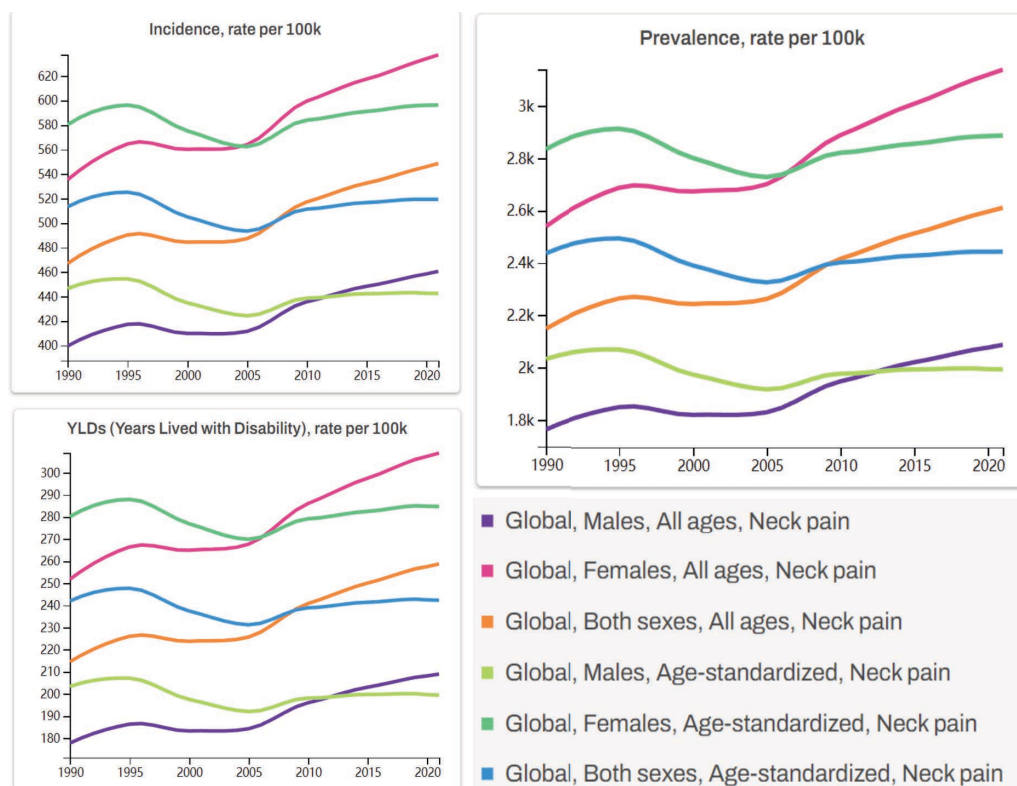


Figure 1. Changes in the number of deaths attributable to risk factors for neck pain in the global population from 1990 to 2021

4. Discussion

This study reveals the global trends and characteristics of neck pain through a systematic analysis of the global burden of neck pain from 1990 to 2021. The results show that from 1990 to 2021, the incidence, prevalence, and years lived with disability (YLDs) of neck pain globally have significantly increased. This trend reflects the severity and complexity of neck pain as a global health problem. Although the age-standardized incidence and prevalence rates have grown relatively modestly, the significant increase in the total number of cases indicates that the impact of neck pain on global health is still intensifying.

The study found that the global incidence and prevalence of neck pain have shown a significant upward trend over the past 30 years. Specifically, the incidence increased from 24.9 million cases in 1990 to 43.26 million cases in 2021, an overall increase of 73.82%; the number of prevalent cases increased from approximately 114 million cases in 1990 to approximately 206 million cases in 2021, an overall increase of 79.78%. However, the age-standardized incidence and prevalence rates grew relatively modestly, at 1.18% and 0.26%, respectively. This indicates that although global population growth and aging have some impact on the incidence and prevalence of neck pain, the actual growth rate is not significant. This phenomenon may be closely related to changes in modern lifestyles, office environments, and occupational habits, especially factors like prolonged sitting and long-term use of electronic devices leading to neck muscle fatigue and injury.

YLDs are an important indicator for measuring the burden of disease, reflecting the loss of healthy life years due to diseases. The results show that from 1990 to 2021, the total YLDs of global neck pain increased

from approximately 114 million to approximately 204 million, an overall increase of 78.42%. The YLD rate per 100,000 population increased from 214.53 in 1990 to 258.71 in 2021, an increase of about 20.59%. However, the age-standardized YLD rate only slightly increased by 0.14%, indicating that considering changes in population structure, the actual burden of neck pain has not changed significantly. This result suggests that although the impact of neck pain on global health has increased in total, its distribution and impact across different age groups have not changed significantly ^[6].

The study also explored the changing trends in incidence, prevalence, and YLDs rates of neck pain across different genders. The results indicate that the incidence, prevalence, and YLDs rates of neck pain in females are higher than those in males and have increased more significantly. This phenomenon may be related to physiological, psychological, and social role differences in females ^[7]. Females are generally more susceptible to musculoskeletal disorders, especially in the neck and shoulder areas. Additionally, exposure factors in occupational choices and work environments may also lead to higher neck pain risk in females ^[8]. This finding emphasizes the need to pay special attention to the health needs of the female population when formulating prevention and intervention strategies.

Based on existing literature and research background, it can be speculated that some major factors may have an important impact on the prevalence trends of neck pain. These factors include: Lifestyle: Modern lifestyles such as prolonged sitting, lack of exercise, and poor posture are important risk factors for neck pain ^[9]. Occupational factors: Occupational exposures such as long-term use of electronic devices and repetitive neck movements may lead to neck muscle fatigue and injury ^[10]. Psychological factors: Psychological factors such as stress and anxiety may exacerbate neck pain symptoms ^[11]. Socioeconomic factors: Levels of socioeconomic development, accessibility, and quality of healthcare services may also affect the incidence and prevalence of neck pain ^[12].

This study, based on data from the Global Burden of Disease (GBD2021) database, provides a comprehensive analysis of the global burden of neck pain ^[13]. However, there are some limitations to the study. First, GBD data may have certain errors and uncertainties, especially in data collection and reporting methods across different countries and regions ^[14]. Secondly, this study did not explore specific attributable risk factors and their relative contributions in detail, which requires further research to clarify ^[15]. Moreover, the study mainly focused on overall global trends and did not deeply analyze differences across different regions and populations, which should be supplemented in future research ^[16].

Future research should further explore the specific risk factors of neck pain and their relative contributions, especially the differences across different regions and populations. Additionally, more intervention studies are needed to evaluate the effectiveness of different prevention and treatment strategies to provide scientific evidence for formulating targeted public health policies. By deeply studying the prevalence trends and influencing factors of neck pain, better prevention and control strategies can be formulated to reduce the burden of neck pain on global health.

Disclosure statement

The authors declare no conflict of interest.

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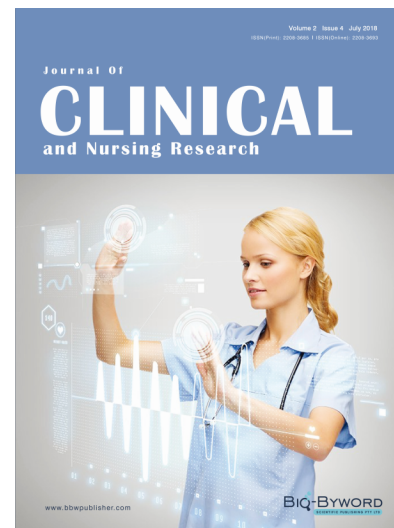
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