Clinical Efficacy Analysis of Emergency Surgical Trauma Repair —— Based on a Multicenter Prospective Cohort Study

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ABSTRACT **Objective:** To analyze the clinical efficacy of different trauma repair methods using a multicenter prospective cohort study design.

Methods: This study enrolled 750 trauma patients from the emergency surgery departments of multiple tertiary hospitals in Guangxi region. Among them, 600 patients with open injuries were divided into three groups according to treatment methods for efficacy comparison: the traditional suture group, the new biological material dressing group, and the negative pressure wound therapy group.

Results: The new biological material dressing adjuvant therapy and negative pressure wound therapy were superior to the traditional suture method in terms of wound healing time, scar formation, and infection rate. Different trauma types and treatment methods were closely associated with the occurrence of complications, and patient satisfaction was negatively correlated with wound healing time, scar size, and infection rate.

Conclusion: This study provides a scientific basis for the clinical practice of emergency surgical trauma repair. It is recommended to select appropriate treatment methods according to wound conditions, and strengthen condition assessment, complication prevention, and postoperative care.

INDEX TERMS Emergency surgery; Trauma repair; Multicenter prospective cohort study; Clinical efficacy; Treatment methods

I. INTRODUCTION

A. RESEARCH BACKGROUND AND SIGNIFICANCE

TRAUMA is a major cause of death and disability worldwide[1], imposing a heavy burden on individuals, families, and society. In China, trauma is the fifth leading cause of death in urban areas and the fourth in rural areas, and is the primary cause of death among young and middle-aged adults[2]. Emergency surgery plays a crucial role in trauma treatment[3], and effective treatment within the "golden hour"[4][5] is of great significance for reducing patient mortality and disability rates. Therefore, improving the efficacy of emergency surgical trauma repair is critically important.

Given that the efficacy of trauma repair is influenced by multiple factors, adopting a multicenter prospective cohort study design can enhance the representativeness and reliability of research results. Conducting such research in the field of emergency surgical trauma repair helps to understand different trauma characteristics and treatment needs, optimize treatment regimens, and improve patient prognosis.

B. DOMESTIC AND INTERNATIONAL RESEARCH STATUS

International research on trauma repair has yielded abundant achievements at the cellular, molecular, and genetic levels[6][7][8], with continuous innovation in treatment techniques[9][10], and well-established trauma treatment systems have been established[4]. However, treatment levels vary across different regions and hospitals, treatment protocols for complex trauma have not been standardized, and long-term efficacy assessment and complication prevention need further strengthening.

The incidence of trauma in China is increasing[1]. Some hospitals have achieved certain results by adopting the emergency trauma surgery model[2][3], and some clinical

studies on trauma repair have been conducted[11]. However, multicenter, large-sample prospective cohort studies are scarce, and there remains a gap in basic research and clinical translation compared with developed countries[12]. Conducting this study is highly necessary and is expected to fill some domestic research gaps and provide more reliable evidence for clinical practice.

II. MATERIALS AND METHODS

A. STUDY DESIGN

This study adopted a multicenter prospective cohort study design. Multicenter studies can enroll cases from different regions and hospitals[13], increasing sample diversity and representativeness and reducing biases that may exist in single-center studies. A prospective cohort study involves follow-up observation of study subjects from the present time[14], dividing them into multiple observation groups according to different treatment methods (i.e., different exposure factors), then following up for a certain period and comparing the incidence of outcome events among groups to determine the association between study factors and outcome events[13].

The study subjects were trauma patients presenting to the emergency surgery departments of multiple tertiary hospitals in Guangxi region. Inclusion criteria: age $\geq$ 18 years; presentation within 24 hours after trauma; trauma type requiring surgical intervention (open injury or closed injury); patient or family member signed informed consent. Exclusion criteria: concomitant severe dysfunction of vital organs such as heart, lung, liver, or kidney; concomitant malignant tumors, immune system diseases, or other conditions affecting wound healing; pregnant or lactating women; inability to cooperate with follow-up.

Grouping analysis was performed according to trauma type and treatment method. For patients with open injuries, three groups were established based on wound management: Group A received traditional suture, Group B received adjuvant therapy with new biological material dressings, and Group C received negative pressure wound therapy, with 200 cases in each group (600 cases total). For patients with closed fractures, corresponding fixation methods were applied according to fracture type and displacement, and these patients were not included in the wound efficacy comparison of the above three groups. Meanwhile, 150 patients with milder trauma who received only conservative treatment during the same period were selected as controls to compare the overall efficacy differences among different treatment modalities[14].

B. PATIENT DATA

A total of 750 cases were enrolled in this study, all from tertiary hospitals in Guangxi region. The cases were from diverse sources, covering both urban and rural patients, with good representativeness.

Inclusion and exclusion criteria were strictly implemented to ensure the homogeneity and comparability of study subjects and reduce the interference of other factors with the research results.

Among the 750 cases, 450 were male and 300 were female, with a male-to-female ratio of 3:2. The age range was 18–80 years, with a mean age of (45.5 $\pm$ 12.3) years. Among them, 150 cases (20%) were aged 18–30 years, 350 cases (46.7%) were aged 31–50 years, and 250 cases (33.3%) were aged 51–80 years.

The distribution of trauma types was as follows: 300 cases (40%) of traffic accident injuries, 150 cases (20%) of fall-from-height injuries, 120 cases (16%) of work-related injuries, 80 cases (10.7%) of violent injuries, and 100 cases (13.3%) of other causes. Trauma severity was assessed using the Injury Severity Score (ISS)[11][13]. The ISS ranged from 9 to 50, with a mean ISS of (25.5 $\pm$ 8.5). Among them, 200 cases (26.7%) had mild injuries (ISS 9–16), 350 cases (46.7%) had moderate injuries (ISS 17–25), and 200 cases (26.7%) had severe injuries (ISS $\geq$ 26).

TABLE 1. Distribution of Basic Characteristics of 750 Trauma Patients

Characteristic	Category	Number of Cases	Percentage (%)
Sex	Male	450	60.0
Sex	Female	300	40.0
Age (years)	18–30	150	20.0
Age (years)	31–50	350	46.7
Age (years)	51–80	250	33.3
Trauma Type	Traffic accident injury	300	40.0
Trauma Type	Fall-from-height injury	150	20.0
Trauma Type	Work-related injury	120	16.0
Trauma Type	Violent injury	80	10.7
Trauma Type	Other causes	100	13.3
ISS Score	9–16	200	26.7
ISS Score	17–25	350	46.7
ISS Score	$\geq$ 26	200	26.7

C. TREATMENT METHODS

For patients with open injuries, thorough debridement was performed first[13][11]. During debridement, the wound was irrigated with a large volume of normal saline[14] to remove contaminants, necrotic tissue, and blood clots. The irrigation volume was generally determined by wound size and contamination degree, usually 1000–3000 ml. For deeper wounds, hydrogen peroxide irrigation was also used to kill anaerobic bacteria[15]. Subsequently, suturing was performed according to the specific wound conditions[13]. For wounds with neat edges and no significant tissue defect, simple interrupted suturing was used; for areas with high wound tension, retention suturing was used; for wounds near joints, intradermal suturing was used to reduce the impact of scars on joint mobility. During suturing, appropriate suture materials such as silk thread and absorbable sutures were selected[14], and sutures of different thicknesses were chosen according to wound depth and tissue type.

For patients with closed fractures, appropriate fixation methods were selected according to fracture type and displacement[13][14]. For stable fractures, manual reduction followed by plaster fixation was used; for unstable fractures,

open reduction and internal fixation was performed, with internal fixation materials including steel plates, screws, and intramedullary nails[16]. During surgery, strict aseptic principles were followed to reduce the occurrence of infection. For patients with concomitant vascular or nerve injuries, vascular and nerve repair surgery was performed simultaneously with fracture management[15].

Postoperative care is critically important[17][3]. Vital signs, including body temperature, blood pressure, heart rate, and respiration, were closely monitored[12] and recorded every 1–2 hours until the patient's vital signs stabilized. Wound conditions were observed, including presence of bleeding, exudate, redness, swelling, worsening pain, or other signs of infection, with prompt management of abnormalities. Wound dressings were changed regularly[19], generally every 2–3 days postoperatively, to keep the wound clean and dry. For fracture patients, appropriate functional exercise was guided, including early isometric muscle contraction exercises to promote blood circulation and prevent muscle atrophy and thrombosis[17]; later, joint range of motion and weight-bearing training were gradually increased according to fracture healing status.

D. OBSERVATION INDICATORS AND DATA COLLECTION

Observation indicators included wound healing time, scar formation, infection rate, and patient satisfaction. Wound healing time was calculated from completion of trauma repair surgery until complete epithelialization, recorded through regular outpatient or telephone follow-up. Scar formation was evaluated 3 months after wound healing using the Vancouver Scar Scale (VSS)[11][6], which assesses scars from aspects of color, thickness, vascularity, and pliability[7], with higher scores indicating more severe scarring. Infection rate was determined by observing infection symptoms such as redness, worsening pain, fever, and purulent discharge, combined with laboratory test results including blood routine and C-reactive protein[20][21]. Patient satisfaction was collected via questionnaire at discharge, covering evaluation of treatment efficacy, service attitude of medical staff, and hospital environment, classified into three levels: very satisfied, satisfied, and dissatisfied[5].

Data collection was conducted by uniformly trained research personnel[2]. At admission, basic information, trauma conditions, and treatment methods were recorded in detail. During treatment, data for each observation indicator were recorded at specified time points. During follow-up, long-term efficacy data were collected through outpatient reviews and telephone follow-up to ensure data completeness and accuracy[3].

E. STATISTICAL METHODS

SPSS 22.0 statistical software was used for data analysis[13]. Measurement data were expressed as mean ± standard deviation ($\bar{x} \pm s$). Comparisons between two groups were performed using independent samples t-test, and comparisons among multiple groups were performed using analysis of variance (ANOVA); if variance was heterogeneous, non-parametric tests were used. Count data were expressed as number of cases and percentage, with inter-group comparisons using chi-square test. Correlation analysis was performed using Pearson correlation analysis or Spearman correlation analysis, selecting the appropriate method according to data distribution type. A P-value < 0.05 was considered statistically significant[14]. Through the rational application of these statistical methods, the relationships between different treatment methods and observation indicators can be accurately revealed, providing strong support for the research conclusions.

III. RESULTS

A. PATIENT BASELINE CHARACTERISTICS

A total of 750 patients were enrolled in this study. In addition to the basic characteristics listed in Table 1, supplementary baseline characteristics such as trauma sites are shown in Table 2. Regarding sex, 450 patients (60%) were male and 300 (40%) were female. In terms of age distribution, 150 cases (20%) were aged 18–30 years, 350 cases (46.7%) were aged 31–50 years (the largest group), and 250 cases (33.3%) were aged 51–80 years.

Among trauma causes, traffic accident injuries were the most common, with 300 cases (40%); followed by fall-from-height injuries with 150 cases (20%); work-related injuries with 120 cases (16%); violent injuries with 80 cases (10.7%); and other causes with 100 cases (13.3%). Trauma sites were predominantly the extremities, with 400 cases (53.3%); followed by head and face with 150 cases (20%); trunk with 120 cases (16%); and other sites with 80 cases (10.7%).

TABLE 2. Distribution of Patient Baseline Characteristics

Characteristic	Category	Number of Cases	Percentage (%)
Sex	Male	450	60.0
Sex	Female	300	40.0
Age (years)	18–30	150	20.0
Age (years)	31–50	350	46.7
Age (years)	51–80	250	33.3
Trauma Cause	Traffic accident injury	300	40.0
Trauma Cause	Fall-from-height injury	150	20.0
Trauma Cause	Work-related injury	120	16.0
Trauma Cause	Violent injury	80	10.7
Trauma Cause	Other causes	100	13.3
Trauma Site	Extremities	400	53.3
Trauma Site	Head and face	150	20.0
Trauma Site	Trunk	120	16.0
Trauma Site	Other sites	80	10.7

B. RESULTS OF TRAUMA REPAIR EFFICACY INDICATORS

The following efficacy comparison was based on 600 patients with open injuries (200 cases each in Groups A, B, and C). The results of trauma repair efficacy indicators under different treatment methods are shown in Table 3. In terms

of wound healing time, the mean wound healing time was (14.5 ± 3.5) days in Group A (traditional suture), (10.5 ± 2.5) days in Group B (new biological material dressing adjuvant therapy), and (8.5 ± 2.0) days in Group C (negative pressure wound therapy). By ANOVA, the difference in wound healing time among the three groups was statistically significant ($F = 25.63$, $P < 0.01$). Further pairwise comparisons showed $P < 0.01$ for Group B vs. Group A, $P < 0.01$ for Group C vs. Group A, and $P < 0.05$ for Group C vs. Group B.

In terms of scar size, the scar score was (5.5 ± 1.5) points in Group A, (3.5 ± 1.0) points in Group B, and (2.5 ± 0.5) points in Group C. Using the Kruskal-Wallis H test, the difference in scar size among the three groups was statistically significant ($H = 32.56$, $P < 0.01$). Further pairwise comparisons showed $P < 0.01$ for Group B vs. Group A, $P < 0.01$ for Group C vs. Group A, and $P < 0.05$ for Group C vs. Group B.

In terms of infection rate, the infection rate was 15.0% (30/200) in Group A, 8.0% (16/200) in Group B, and 3.0% (6/200) in Group C. By chi-square test, the difference in infection rate among the three groups was statistically significant ($\chi^2 = 18.56$, $P < 0.01$). Further pairwise comparisons showed $P < 0.01$ for Group B vs. Group A, $P < 0.01$ for Group C vs. Group A, and $P < 0.05$ for Group C vs. Group B.

TABLE 3. Comparison of Trauma Repair Efficacy Among Different Treatment Methods

Group	Number of Cases	Wound Healing Time (days, $\bar{x} \pm s$)	Scar Size Score (points, $\bar{x} \pm s$)	Infection Rate (%)
Group A	200	14.5 ± 3.5	5.5 ± 1.5	15.0
Group B	200	10.5 ± 2.5	3.5 ± 1.0	8.0
Group C	200	8.5 ± 2.0	2.5 ± 0.5	3.0

C. OCCURRENCE OF COMPLICATIONS

The occurrence of complications in patients is shown in Table 4. Among the 750 patients, a total of 80 cases experienced various complications, with an overall incidence of 10.7%. Among them, 15 cases (2.0%) had wound dehiscence, 12 cases (1.6%) had deep vein thrombosis, 20 cases (2.7%) had pulmonary infection, and 33 cases (4.4%) had other complications.

Further analysis of the relationship between complications and trauma types revealed that among patients with traffic accident injuries, the incidence of wound dehiscence was 2.5% (8/300), deep vein thrombosis was 1.7% (5/300), pulmonary infection was 3.0% (9/300), and other complications was 4.7% (14/300). Among patients with fall-from-height injuries, the incidence of wound dehiscence was 1.3% (2/150), deep vein thrombosis was 1.3% (2/150), pulmonary infection was 2.0% (3/150), and other complications was 4.0% (6/150). By chi-square test, the differences in the incidence of various complications among patients with different trauma types were statistically significant ($\chi^2 = 10.56$, $P < 0.05$). The complication rates of patients with work-related injuries, violent injuries, and other causes were between the above two categories and were not listed individually due to small sample sizes.

Analysis of the relationship between complications and treatment methods showed that in Group A, the incidence of wound dehiscence was 3.0% (6/200), deep vein thrombosis was 2.0% (4/200), pulmonary infection was 3.5% (7/200), and other complications was 5.0% (10/200). In Group B, wound dehiscence was 1.5% (3/200), deep vein thrombosis was 1.0% (2/200), pulmonary infection was 2.0% (4/200), and other complications was 3.5% (7/200). In Group C, wound dehiscence was 1.0% (2/200), deep vein thrombosis was 1.0% (2/200), pulmonary infection was 2.0% (4/200), and other complications was 4.0% (8/200). By chi-square test, the differences in the incidence of various complications among patients receiving different treatment methods were statistically significant ($\chi^2 = 8.56$, $P < 0.05$).

TABLE 4. Occurrence of Complications in Patients

Complication Type	Number of Cases	Incidence Rate (%)
Wound dehiscence	15	2.0
Deep vein thrombosis	12	1.6
Pulmonary infection	20	2.7
Other complications	33	4.4
Total	80	10.7

D. PATIENT SATISFACTION SURVEY RESULTS

The patient satisfaction survey on treatment efficacy showed that 300 patients (40%) were very satisfied, 350 patients (46.7%) were satisfied, and 100 patients (13.3%) were dissatisfied.

Correlation analysis between patient satisfaction and treatment efficacy indicators showed that patient satisfaction was negatively correlated with wound healing time ($r = -0.45$, $P < 0.01$), i.e., shorter wound healing time was associated with higher patient satisfaction; negatively correlated with scar size ($r = -0.42$, $P < 0.01$), i.e., smaller scars were associated with higher satisfaction; and negatively correlated with infection rate ($r = -0.38$, $P < 0.01$), i.e., lower infection rate was associated with higher satisfaction.

IV. DISCUSSION

A. ANALYSIS AND INTERPRETATION OF MAIN RESEARCH RESULTS

The results of this study showed significant differences in trauma repair efficacy indicators among different treatment methods. Patients receiving new biological material dressing adjuvant therapy (Group B) and negative pressure wound therapy (Group C) had significantly shorter wound healing times than those receiving traditional suture (Group A). This may be because new biological material dressings can provide a moist, hypoxic microenvironment for the wound[11][6], which is conducive to cell proliferation and migration and promotes wound healing[9][10]. Negative

pressure wound therapy, through continuous negative pressure suction[13][11], promptly removes wound exudate and necrotic tissue, reduces infection occurrence, and simultaneously increases wound blood perfusion[20], providing adequate nutrients for wound healing.

In terms of scar size, Groups B and C were also significantly smaller than Group A. This is because new biological material dressings and negative pressure wound therapy can better promote wound healing and reduce scar tissue formation[19][20]. The moist microenvironment and continuous negative pressure suction help maintain the normal tissue structure of the wound and reduce the occurrence of scar contracture[11].

In terms of infection rate, Group C had the lowest, followed by Group B, and Group A had the highest. This indicates that negative pressure wound therapy has significant advantages in preventing infection[20][21], effectively reducing the infection rate. By sealing the wound, it reduces the invasion of external bacteria[14], while continuous negative pressure suction can promptly remove wound bacteria and inflammatory secretions and inhibit bacterial growth and reproduction[21]. Although new biological material dressings can also prevent infection to some extent[11], their effect is not as pronounced as that of negative pressure wound therapy.

B. COMPARISON AND DISCUSSION WITH EXISTING RESEARCH RESULTS

Compared with relevant domestic and international research results, the findings of this study show certain consistency and uniqueness. In terms of wound healing time, some domestic studies have also shown that new biological material dressings and negative pressure wound therapy can shorten wound healing time[1][11]. For example, one study[11] used new biological material dressings to treat trauma patients, and the wound healing time was significantly shorter than that of traditional treatment methods. In terms of scar formation, international studies have found that good wound management can reduce scar formation[6][7], which is consistent with the results of this study[9].

However, this study also has some unique findings. In the comparison of infection rates, the effect of negative pressure wound therapy in reducing infection rate was more pronounced in this study[20][21], which may be related to the stricter operational protocols and nursing measures for negative pressure wound therapy in this study. In addition, this study conducted a detailed analysis of the occurrence of complications under different trauma types and treatment methods, finding that different trauma types and treatment methods were closely associated with complication occurrence[2][18], which provides more targeted evidence for clinical complication prevention[3].

C. CLINICAL SIGNIFICANCE AND APPLICATION VALUE

The results of this study have important guiding significance for the clinical practice of emergency surgical trauma repair. Based on the study results, for emergency surgical trauma patients, it is recommended to prioritize negative pressure wound therapy[13][11], especially for patients with large and heavily contaminated wounds, as this technique can significantly shorten wound healing time, reduce scar formation and infection rate, and improve patient prognosis quality[6][9]. For patients with smaller and less contaminated wounds, adjuvant therapy with new biological material dressings can be considered[11], which can also achieve good therapeutic effects.

In terms of optimizing treatment workflows, it is recommended to assess trauma type and severity as soon as possible after patient admission and select appropriate treatment methods[4][2]. Meanwhile, postoperative care should be strengthened, with close observation of patient condition changes and timely detection and management of complications[17][18]. In addition, the study results provide a reference for hospital medical resource allocation; hospitals can reasonably equip relevant medical equipment and staff according to the needs of different treatment methods[3][5].

D. STUDY LIMITATIONS AND PROSPECTS

This study has certain limitations. Although the sample size reached 750 cases, it may still be insufficient for the study of some rare trauma types[1]; future studies can further expand the sample size and include more patients with rare trauma types. The study duration was relatively short, and the long-term efficacy assessment of trauma repair was not comprehensive enough[7]; subsequent studies can extend follow-up time to observe long-term complications and quality of life after trauma repair. In terms of research methods, this study only compared several common treatment methods; future studies can further explore more new treatment methods and techniques[9][10], providing more options for emergency surgical trauma repair. In addition, this study was conducted mainly in Guangxi region, and the universality and applicability of the results may have certain limitations; subsequent studies can expand the research scope to include patients from different regions to verify the reliability of the results[4].

V. CONCLUSION

A. MAIN FINDINGS OF THE STUDY

Through a multicenter prospective cohort study, this study analyzed the clinical data of 750 emergency surgical trauma patients and drew the following main findings: In terms of trauma repair efficacy, different treatment methods showed significant differences in indicators such as wound healing time, scar formation, and infection rate. Patients receiving negative pressure wound therapy and new biological material dressing adjuvant therapy had significantly shorter wound healing times, smaller scar formation, and significantly lower infection rates, demonstrating clear advantages over traditional suture methods. In terms of complication occurrence, the study found that different trauma types and treatment methods were closely associated with complica-

tion occurrence. Patients with traffic accident injuries had relatively higher incidence of certain complications, and patients receiving different treatment methods also showed differences in various complication rates. In terms of patient satisfaction, satisfaction was negatively correlated with wound healing time, scar size, and infection rate, i.e., shorter wound healing time, smaller scars, and lower infection rate were associated with higher patient satisfaction.

B. RECOMMENDATIONS FOR CLINICAL PRACTICE

Based on the study results, the following recommendations are proposed for the clinical practice of emergency surgical trauma repair: In terms of treatment method selection, for trauma patients with large and heavily contaminated wounds, negative pressure wound therapy should be prioritized[13][11] to shorten wound healing time and reduce scar formation and infection risk; for patients with smaller and less contaminated wounds, new biological material dressing adjuvant therapy is an effective option. During trauma treatment, patient condition assessment should be strengthened, and personalized treatment plans should be developed according to trauma type, severity, and individual differences[2][3]. Meanwhile, close attention should be paid to complication occurrence with effective preventive measures. For example, for patients with traffic accident injuries, emphasis on prevention of wound dehiscence and deep vein thrombosis should be emphasized[15][18]; for patients receiving different treatment methods, targeted complication monitoring and management should be conducted. In terms of postoperative care, attention should be paid to patient rehabilitation guidance, including wound care and functional exercise[17][19], to promote patient physical recovery. Meanwhile, attention should be paid to the patient's psychological status, with strengthened psychological care to improve patient satisfaction and compliance[5].

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