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Original Article
Antibiotic bone cement combined with vacuum sealing drainage effectively repairs sacrococcygeal pressure ulcer

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Abstract: Objective: To investigate the effectiveness of antibiotic bone cement combined with the vacuum sealing drainage (VSD) technique for repairing sacrococcygeal pressure ulcer wounds. Methods: A retrospective analysis was conducted on data from 136 patients treated at Yantai Affiliated Hospital of Binzhou Medical College between May 2020 and June 2022. The cases were devided into a control group and a study group according to their treatment regimen. Indicators of postoperative recovery including blood routine recovery time, hospital stay, antibiotic application time, and healing time were compared between the two groups. Before the procedure and 6, 12, 24, and 48 hours following the operation, the pain levels of patients in both groups were examined using a visual analogue scale (VAS). On the 3rd, 7th, 14th, 21st, and 28th days of treatment, the pressure ulcer scale for healing (PUSH) was used to measure the pressure ulcer area between the two groups. On the 7th, 14th, 21st, and 28th days following treatment, the capillary density values were compared between the two groups, along with the levels of interleukin-1β (IL-1β), interleukin-12 (IL-12), and C-reactive protein (CRP). The proportions of immunoglobulin M (IgM) and immunoglobulin G (IgG) levels, CD3+, CD4+, and CD8+ T cell subsets, as well as CD4+/CD8+ ratio, were compared between the two groups. Results: The blood routine recovery time, hospital stays, antibiotic usage duration, and healing time were all significantly shorter in the study group compared to those in the control group (all $P<0.05$). At 6 h, 12 h, 24 h, and 48 h following surgery, the VAS score in study group was significantly lower than that of the control group ($P<0.05$). The study group also showed a greater reduction in pressure ulcer area, with lower PUSH scores observed on days 14, 21, and 28 ($P<0.05$). Post-treatment levels of IL-1β, IL-12, and CRP decreased in both groups, with significantly lower levels in the study group ($P<0.05$). Following therapy, both groups demonstrated significantly increased levels of CD3+, CD4+, CD4+/CD8+, IgM and IgG and reduced level of CD8+. These improvements were more pronounced in the study group (all $P<0.05$). Conclusion: The combination of antibiotic bone cement and VSD is effective in enhancing recovery, reducing pain and inflammation, and improving immune response in the treatment of sacrococcygeal pressure ulcers.

Keywords: Antibiotic bone cement, vacuum sealing drainage, sacrococcygeal pressure ulcer

Introduction

Sacrococcygeal pressure ulcers are common clinical pressure ulcers. These ulcers, particularly when large or penetrating to the bone, present significant treatment challenges. Flap transplantation has been used for the treatment of pressure ulcers, but infection and necrosis may occur due to poor blood supply [1, 2]. Vacuum sealing drainage (VSD) has been extensively used in managing infected wounds and soft tissue defects of extremities, effectively reducing cross-infection and shortening treatment duration [3, 4].

In orthopedic surgery, applications such as filling bone cavities and fixing implants are common. The recovery cycle of infected wounds

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treated with conventional VSD is long, along with slow granulation growth and even repeated infection, which may exacerbate the condition. Antibiotic bone cement, known for its high mechanical strength, offers sustained antibiotic release that effectively treat bone defects and joint infections among other diseases [5, 6]. In addition, antibiotic bone cement can facilitate the formation of a bio-inductive membrane around the bone cement to promote wound healing [7, 8]. This study explores the combined use of antibiotic bone cement with VSD technology in treating sacrococcygeal pressure ulcers, aiming to evaluate its therapeutic effects and provide clinical guidance.

Materials and methods

General information

This retrospective study was conducted in accordance with the ethical standards of the institution and adhered to the 1964 Helsinki declaration and its subsequent amendments. Ethical approval was granted by the Ethics Committee of Medical Ethics Committee of Yantai Affiliated Hospital of Binzhou Medical College (Ethical Document Number: 20200-301066). We analyzed data from 136 hospitalized patients in Yantai Affiliated Hospital of Binzhou Medical College from May 2020 to June 2022. Patients were divided into a control group (VSD only) and a study group (antibiotic bone cement +VSD) based on different wound intervention methods they recieved, with 68 patients in each group.

Inclusion criteria

① Patients who met the diagnostic criteria for pressure sacrococcygeal ulcers [9]; ② Pateints with an age of 18-80 years old; ③ Pateints in good nutritional status who could tolerate the treatment.

Exclusion criteria

① Patients with severe respiratory disease or heart disease; ② Patients with severe consciousness disorder or dementia; ③ Patients with multiple systemic pressure ulcers; ④ Patients with severe diabetes and uncontrolled blood glucose level; ⑤ Patients with acute traumatic wounds; ⑥ Patients received treatment involving various growth factors.

Methods

Preoperative preparation: Patients underwent routine physical examination, and those with hypoproteinemia and anemia were given blood products or nutritional support to improve their overall nutritional status. Bacterial culture and drug sensitivity test were performed on wound secretions, and the dressings were routinely changed, removing necrotic tissue to ensure a clean wound.

Production of bone cement chain beads: A total of 44.9 g of methyl acrylate-methyl methacrylate polymer bone cement (Jiangsu Lekai Biotechnology Co., Ltd.) was mixed with 1 g of vancomycin (Hunan Yunbang Biotechnology Co., Ltd.). The bone cement solvent was added and thoroughly stirred into a paste, which was made into a number of medicine beads with a diameter of 1.00 cm. Nonabsorbable sutures were used to connect the beads in series, and they were kept in a sterile state for later use.

Vancomycin was chosen for its broad-spectrum activityagainst gram-positive bacteria, making it effective against most pathogens that commonly cause surgical site infections. The half-life of vancomycin in bone cement follows an exponential decay pattern, with most of the antibiotic released during the first few hours after mixing and a small amount continuously released over several weeks [10].

Specific operations: The patient was placed in the prone position, followed by conventional disinfection and draping. The wound was rinsed repeatedly with hydrogen peroxide and 0.9% sodium chloride solution to remove the inactivated skin and subcutaneous tissue, the tissue with good blood supply was preserved, and the necrotic bone was removed until fresh blood oozed through the bone surface. Once the wound was clean and free of significant bleeding, treatment protocols were applied to the two groups. For the control group, a Vacuum Sealing Drainage (VSD) system (provided by Guangzhou Meijie Weitong Biotechnology Co., Ltd.) was implemented. VSD dressings were tailored to the wound's size and shape to ensure full contact and adherence without any gaps. The biofilm was securely wrapped around the dressing, and the drainage tube was centrally connected to maintain a consistent negative pressure of -20 kPa. In the study group, antibiotic chain beads were used to fill the wound cavity. Before applying VSD, air leak or exudation was carefully checked. VSD was discontinued once the inflammation resolved. Following device removal, both groups underwent further debridement and received skin grafts or flap transplants depending on the extent of the skin and soft tissue defects.

Observation indicators

① Surgical markers. The surgical recovery metrics including blood routine recovery time, hospitalization time, antibiotic application duration, and healing time were compared between the two groups. ② Pain level. Before the procedure and at 6, 12, 24, and 48 hours following the operation, the pain was assessed using the visual analogue scale (VAS). The VAS score ranges from 0-10 points, with 1-3 points indicating mild discomfort, 4-6 points for moderate pain, and 7-10 points signifying severe pain. ③ Healing of pressure ulcers. The pressure ulcer area in the two groups was compared using the Pressure Sore Scale for Healing (PUSH) [11] on the 3rd, 7th, 14th, 21st, and 28th day after treatment, and the two groups' treatment outcomes were compared. This scale, ranging from 0 to 17, evaluates wound area, tissue morphology, and exudate amount. Lower scores indicate better recovery. ④ Inflammation. 5 ml of fasting venous blood was taken from the individuals in both groups, and centrifuged at 1000 g for 15 minutes. The supernatant was collected and stored at -80°C. The levels of interleukin-1 β (IL-1 β), interleukin-12 (IL-12), and acute phase protein (CRP) were measured by enzyme-linked immunosorbent assay (ELISA). ⑤ Capillary density. At 7, 14, 21, and 28 days after treatment, wound specimens of the two groups were collected, fixed with neutral formaldehyde, embedded in paraffin, sectioned at 4 μm, deparaffinized, and rehydrated in gradient alcohol to water with 3% H_2O_2 for 10 min, washed with clean water twice, and boiled with citric acid buffer twice. Subsequently, the specimens underwent immunohistochemical staining for CD34 using the Streptavidin-Biotin Complex (SABC) method. The process included washing the specimens twice with buffer solution, sealing with goat serum, and incubating with mouse anti-human monoclonal CD34 antibody (Folide Biotechnology, Wuhan, Co., LTD.; Catalog No: CCM-0550) at 4°C overnight. The specimens were then treated with HRP-labeled goat anti-rabbit secondary antibody (EMAG Technology Co., LTD.; Catalog No: 111-035-003), developed for color with a chromogen, and counterstained with hematoxylin. After dehydration, the specimens were cleared in xylene, and a sealing sheet was applied and dried. Capillary density, quantified as the number of crossed blood vessels per ten high-power fields (HPF), was observed under a light microscope to evaluate the extent of granulation tissue hyperplasia. A higher number of capillaries indicates more robust wound healing and faster growth of granulation tissue. ⑥ Immune function. To evaluate specific cell characteristics, fluorescently-labeled antibodies targeting cell surface antigens or intracellular markers were employed. These antibodies, conjugated with fluorochromes, emit fluorescence when excited by specific wavelengths of light. Using flow cytometry (equipment: Northern Lights 1L-3L, USA; software: Kaluza 3.1), the percentages of CD3+ (Normal range is generally considered to be between 60% and 85% of total lymphocytes) (ab16669, Abcam, USA), CD4+ (The normal counts range between 500 to 1500 cells per cubic millimeter (cells/mm^3)) (ab133616, Abcam, USA), CD8+ (The normal counts range from 150 to 1000 cells per cubic millimeter (cells/mm^3)) (ab237709, Abcam, USA), and CD4+/CD8+ T cell subsets (This ratio normal value ranges between 1.0 and 4.0). All dilution were 1/500 (20 min at 4°C) were measured. By using an enzyme-linked immunosorbent test, the levels of immunoglobulin M (IgM) (ab137982, Abcam, USA), and immunoglobulin G (IgG) (ab195215, Abcam, USA) were measured.

The primary endpoints were pressure ulcer healing (pressure ulcer area and PUSH score), and the secondary endpoint were surgical indexes, pain situation, inflammation indexes, capillary density value and immune function. Among the observation indicators, surgical markers, pain level, and healing of pressure ulcers were the main indicators of this study, while inflammation, capillary density value, and immune function are secondary indicators.

Wound healing criteria

Wound healing was assessed based on the absence of redness or swelling, no exudation,

Table 1. Comparison of postoperative recovery between the two groups ($x \pm s$, *d*)

Group	Blood routine recovery time	Hospitalization time	Antibiotic application time	Healing time
Study group (*n*=68)	3.43±0.53	29.84±6.48	18.54±2.70	26.43±2.09
Control group (*n*=68)	3.88±0.60	49.90±6.71	28.44±2.57	43.97±4.94
t value	4.571	17.733	21.886	26.993
P value (Student's t-test)	<0.001	<0.001	<0.001	<0.001

Note: Independent sample *t* test was used.

no dead space or fluctuation sensation in the wound, and close growth of skin margin tissues. The area of pressure ulcers for both groups was measured using the Measurement Method of Length and Area of Irregular Injury [12].

Statistical methods

SPSS 20.0 was used to process and analyze the collected data. Measured data were expressed as mean ± standard deviation, and independent sample t-test, paired t-tests, repeated measures ANOVA, or one way ANOVA followed by Turkey's test were adopted for data analysis. Counted data were expressed as frequency or composition ratio (n, %) and analyzed by using a chi square test. $P<0.05$ was considered a significant difference.

Results

Comparison of general information between the two groups

The study group consisted of 68 patients, with 42 males and 26 females. The average age was 64.74±4.75 years (54-76). Among them, 28 cases were bedridden after fracture surgery, 22 cases were bedridden after stroke, and 18 cases were paraplegic, with an average bed rest duration of 5.81±1.14 years (3-9). The control group included 68 patients with 38 males and 30 females, averaging 65.31±6.10 years (52-79). Among them, 32 cases were bedridden after fracture surgery, 20 cases were bedridden after stroke and 16 cases were paraplegic, with a bed rest duration of 6.13±1.62 years (3-12). Statistical comparison of general data between the groups showed no significant differences ($P>0.05$).

Comparison of postoperative recovery between the two groups

Our primary focus was on post-treatment healing measurements. The study group showed significant improvements in the healing, demonstrating faster blood routine recovery time, shorter hospitalization stays, reduced antibiotic application duration, and quicker overall healing times compared to the control group (all $P>0.05$), as shown in **Table 1** and **Figure 1**.

Comparison of pain conditions between the two groups

There was no obvious difference in VAS score between the two groups before to the operation ($P>0.05$). However, at 6 h, 12 h, 24 h, and 48 h following surgery, the study group revealed lower VAS scores in comparison to that of the control group (all $P<0.05$), as shown in **Table 2**.

Comparison of pressure ulcer area before and after treatment between the two groups

The pressure ulcer area for both groups was measured using the Measurement Method for Length and Area of Irregular Injury [12]. Initially, there was no significant difference in pressure ulcer areas between the two groups prior to therapy (P>0.05). Post-treatment, both groups showed a reduction in pressure ulcer size; however, the pressure ulcer area in study group was significantly smaller than that of the control group (P<0.05), as presented in **Table 3**.

Comparison of PUSH scores between the two groups

On the 3rd and 7th days of treatment, no appreciable difference in PUSH scores was found between the two groups ($P>0.05$). However, subsequent assessments on the 14th, 21st, and 28th days revealed that the study group had significantly lower PUSH scores compared

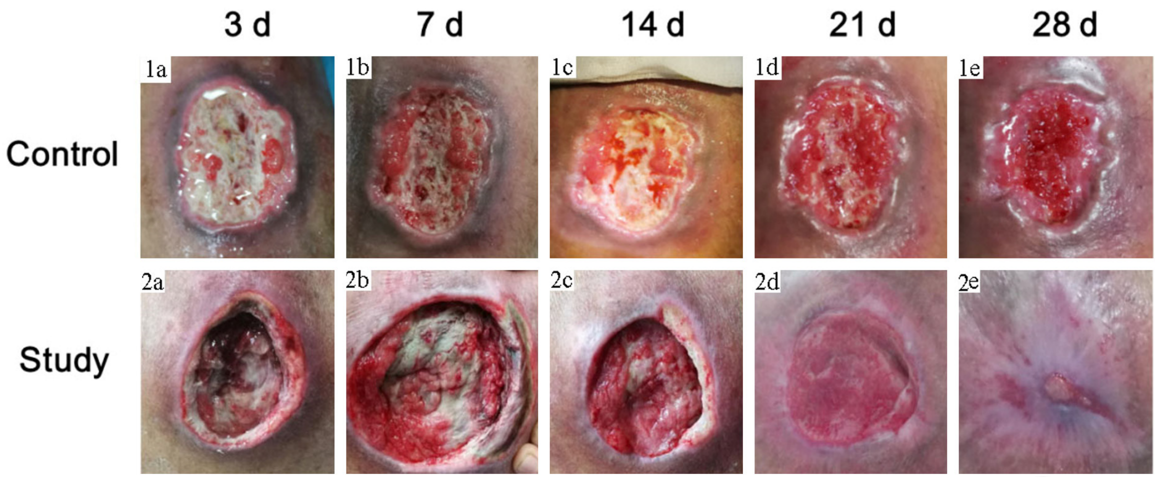

Figure 1. Comparison of postoperative recovery between the two groups. Note: 1a: Wound surface on day 3 after dressing change. 1b: Wound surface on the 7th day after dressing change. 1c: Wound surface on the 14th day after dressing change. 1d: Wound surface on the 21st day after dressing change. 1e: Wound surface on the 28th day after dressing change. 2a: Wound surface on day 3 after dressing change. 2b: Wound surface on the 7th day after dressing change. 2c: Wound surface on the 14th day after dressing change. 2d: Wound surface on the 21st day after dressing change. 2e: Wound surface on the 28th day of dressing change.

Table 2. Comparison of pain level between the two groups ($\overline{x}$±s, points)

Group	Before operation	6 h after operation	12 h after operation	24 h after operation	48 h after operation
Study group (*n*=68)	1.72±0.79	3.35±1.05[a]	4.25±0.90[a]	4.37±0.98[a]	3.93±0.89[a]
Control group (*n*=68)	1.68±0.89	4.00±1.32[a]	4.65±0.71[a]	4.87±0.67[a]	4.50±0.74[a]
t value	0.306	3.172	2.852	3.488	4.089
P value (Student's t-test)	0.760	0.002	0.005	0.001	<0.001

Note: [a]*P*<0.05, compared to the same group before treatment. Independent sample t test and paired sample t test were used.

Table 3. Comparison of pressure ulcer area between the two groups before and after treatment (*x*±s, cm^2)

Group	Before treatment	After treatment
Study group (*n*=68)	95.76±11.76	7.35±0.50[a]
Control group (*n*=68)	94.15±9.45	18.76±4.15[a]
t value	0.880	22.488
P value (Student's t-test)	0.380	<0.001

Note: [a]*P*<0.05, compared to the same group before treatment. Independent sample t test and paired sample t test were used.

to the control group (P<0.05), as presented in **Table 4**.

Comparison of serum inflammatory index levels between the two groups

Before treatment, there were no significant differences in the levels of IL-1β, CRP, or IL-12 between the two groups (all *P*>0.05). After treatment, the levels of IL-1β, CRP and IL-12 in the two groups were decreased, and the levels of IL-1β, CRP and IL-12 in the study group were significantly lower than those of the control group (all *P*< 0.05), as shown in **Table 5**.

Comparison of capillary density value at each time point after treatment between the two groups

On the 7, 14, 21, and 28 days following treatment, the capillary density value in the study group was significantly lower than that in the control group (*P*<0.05), as presented in **Table 6**.

Comparison of immune function index levels between the two groups

Before treatment, there were no discernible differences in the levels of CD3+, CD4+, CD8+, CD4+/CD8+, IgM, and IgG between the two groups (all *P*>0.05). Following therapy, both groups exhibited increased CD3+, CD4+, CD4+/

Table 4. Comparison of PUSH score between the two groups ($\bar{x}\pm s$, points)

Group	Before treatment	3rd of treatment	7th of treatment	14th of treatment	21st of treatment	28th of treatment
Study group (*n*=68)	14.40±2.58	13.22±2.14	10.72±1.71[a]	7.19±0.76[a]	5.54±0.66[a]	4.04±0.66[a]
Control group (*n*=68)	13.74±2.43	13.37±2.46	11.31±2.15[a]	9.25±1.86[a]	7.35±0.73[a]	5.96±0.72[a]
t value	1.542	0.372	1.768	8.469	15.214	16.164
P value (Student's t-test)	0.126	0.710	0.079	<0.001	<0.001	<0.001

Note: [a]$P<0.05$, compared to the same group before treatment. Independent sample t test and paired sample t test were used.

Table 5. Comparison of serum inflammatory factor levels between the two groups ($\bar{x}\pm s$)

Group	IL-1β (ng/l)		CRP (mg/l)		IL-12 (ng/l)	
	Before treatment	After treatment	Before treatment	After treatment	Before treatment	After treatment
Study group (*n*=68)	42.31±4.82	10.29±0.90[a]	44.08±8.72	10.31±3.63[a]	20.30±2.44	10.80±1.53[a]
Control group (*n*=68)	41.44±4.74	21.34±2.42[a]	43.99±7.90	24.33±7.11[a]	19.99±2.84	15.33±1.52[a]
t value	1.061	35.310	0.061	14.486	0.688	17.305
P value (Student's t-test)	0.291	<0.001	0.951	<0.001	0.493	<0.001

Note: [a]$P<0.05$, compared to the same group before treatment. Independent sample t test and paired sample t test were used. IL-1β: interleukin-1β, CRP: C-reactive protein, IL-12: interleukin-12.

Table 6. Comparison of capillary density value between the two groups at each time point after treatment ($\bar{x}\pm s$, 10 HP)

Group	7 d	14 d	21 d	28 d
Study group (*n*=68)	38.63±9.48	45.07±11.51	55.09±9.54	57.72±10.98
Control group (*n*=68)	20.72±6.05	26.69±7.26	36.72±9.50	35.27±8.70
t value	13.137	11.131	11.254	13.218
P value (Student's t-test)	<0.001	<0.001	<0.001	<0.001

Note: Independent sample *t* test was used.

CD8+, IgM, and IgG levels, and decreased CD8+ level. Notably, the improvements in these immune function indices were more pronounced in the study group compared to the control group (P<0.05), as presented in **Figure 2**.

Discussion

Sacrococcygeal pressure ulcers are prevalent in patients who have been bedridden for extended periods due to conditions such as paraplegia, bone and joint diseases, and old age, among others. Contributing factors include poor nutritional intake, diminished subcutaneous tissue, prolonged immobilization, sustained local compression ischemia, and inadequate care [13, 14]. Sacrococcygeal pressure ulcers are often accompanied by complications such as electrolyte imbalance, anemia, infection, bacteremia, and sepsis, which can seriously endanger the patient's life and health [15]. Clinically, skin flap transplantation is a frequent method for treating pressure ulcers. However, challenges such as limited skin elasticity around the sacrococcygeal region, high postoperative wound tension, and susceptibility to fecal contamination often lead to complications such as wound infection and poor flap healing [16, 17]. Vacuum sealing drainage (VSD) technology has become crucial in the treatment of pressure ulcers. It adopts a special permeable paste film to seal the ulcer surface, while continuous negative pressure suction using a multi-hole drainage tube helps eliminate wound secretions, necrotic tissues, and alleviate edema and inflammation. Studies suggest that VSD can inhibit bacterial propagation and reduce the immune protease activity in wounds, effectively controlling wound infec-

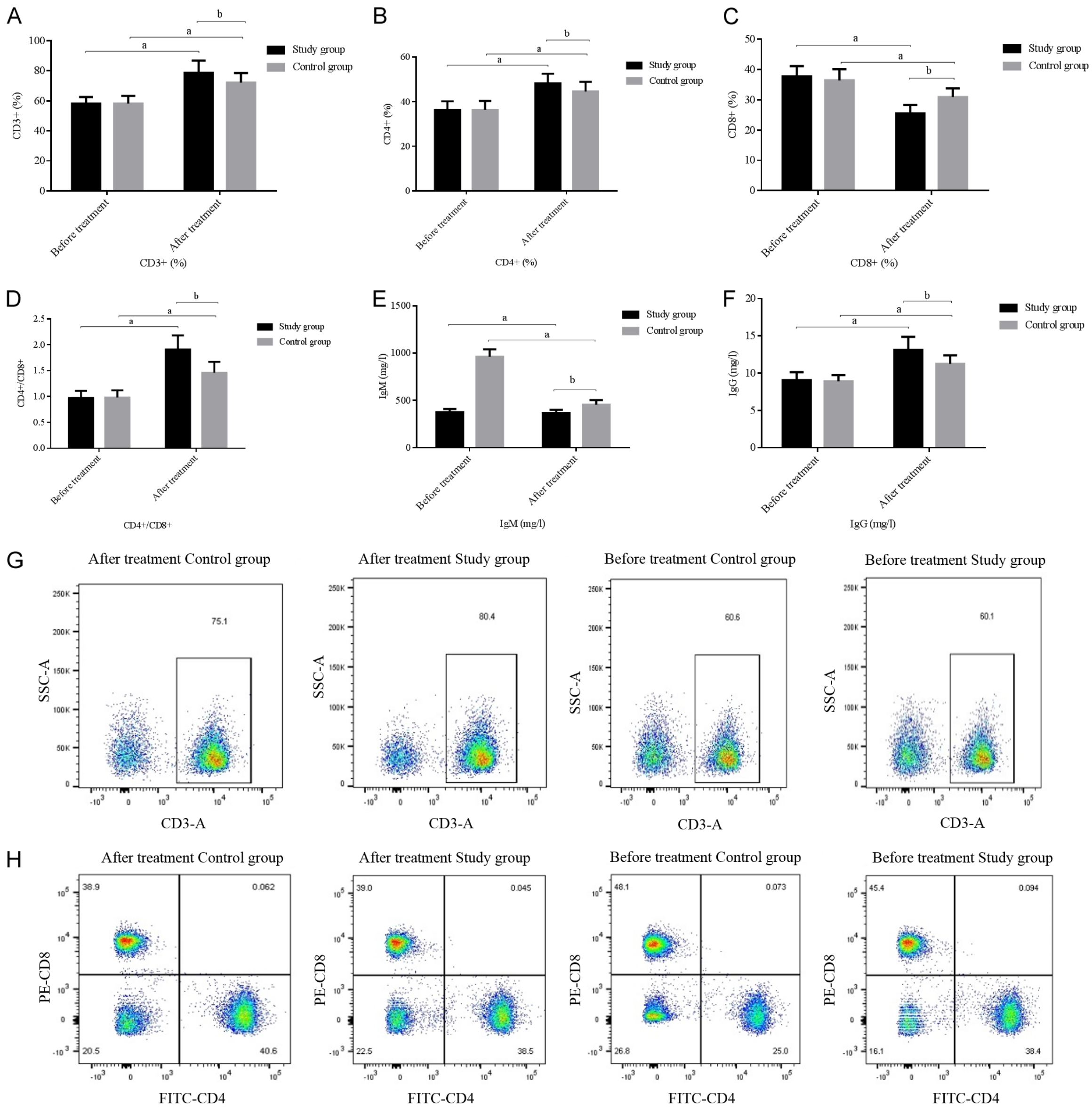

Figure 2. Comparison of immune function index levels between the two groups. A: Changes in CD3+ levels before and after treatment in two groups; B: Changes in CD4+ levels before and after treatment in two groups; C: Changes in CD8+ levels before and after treatment in two groups; D: Changes in CD4+/CD8+ ratios before and after treatment in two groups; E: Changes in IgM levels before and after treatment in two groups; F: Changes in IgG levels before and after treatment in two groups; G: Flow cytometry of changes in CD3+ levels before and after treatment in two groups; H: Flow cytometry of changes in CD4+, CD8+, and CD4+/CD8+ levels before and after treatment in two groups. Note: [a]P<0.05, compared to the same group before treatment. [b]P<0.05, compared with the two groups. Independent sample t test and paired sample t test were used. IgM: immunoglobulin M, IgG: immunoglobulin G.

tion [18, 19]. Antibiotic cement serves as a localized antibiotic delivery system, releasing high concentrations of antibiotics directly to the infected area. Compared to systemic medication, it can reduce liver and kidney adverse reactions compared with systemic drugs [20, 21]. The integration of antibiotics and bone cement into cement beads not only facilitates the removal of necrotic tissue, but also promotes fracture healing and granulation tissue growth, creating favorable conditions for soft tissue repair. Due to the high strength of bone cement, it can effectively shorten the length of hospital stay and promote the postoperative recovery of patients [22-25].

Our study systematically analyzed the comprehensive factors, including patient demographics, postoperative recovery, pain management, wound healing, pressure ulcer dimensions, inflammatory markers, capillary density, and immune response. The study group exhibited superior healing outcomes, reduced postoperative pain, shorter hospital stays, and reduced antibiotic usage. Notably, the study group also demonstrated significantly reduced pressure ulcer area and PUSH score, lower serum inflammatory index levels, increased blood vessel density values, and enhanced immune function index. These findings highlight the efficacy of the interventions studied, suggesting possible improvements in patient care and recovery protocols. This may be because antibiotic cement combined with VSD has a stronger anti-infection effect compared to conventional antibiotics, which can reduce wound infection and reduce pain caused by further treatment. The reduction in pain observed in the study group surpassed that in the control group, which may be due to the rapid healing facilitated by the treatment, overcoming the typical drawbacks of VSD, such as delayed repair and prolonged pain duration. The results of the current work corroborate quite well those of other studies that support the superior effectiveness of using antibiotic bone cement in conjunction with VSD over VSD alone in treating infected wounds [26, 27]. Pressure ulcers often develop and worsen due to inflammatory processes. Persistent inflammation can lead to the production of enzymes that interfere with wound healing by degrading fibrin and the cellular matrix, thereby exacerbating tissue damage [28]. The measurement of C-reactive protein (CRP) levels can reflect the extent of inflammation, acting as a marker of inflammatory response. In this study, the levels of IL-1β, CRP, and IL-12 in the study group were notably lower compared to those of the control group, showing that the combination of antibiotic bone cement and VSD can efficiently reduce the inflammatory response in patients with sacrococcygeal pressure ulcers. This effect is likely due to the local release of high concentrations of sensitive antibiotics by the antibiotic bone cement beads, which maintain high drug levels at the infection site while keeping serum concentrations low, thereby minimizing adverse reactions and maximizing anti-infective efficacy. In this study, the improvement in immune function indices, such as CD3+, CD4+, CD8+, CD4+/CD8+ ratio, IgM, and IgG, was more pronounced in the study group than those of the control group, implying that the use of antibiotic bone cement in conjunction with VSD has notable benefits in treating sacrococcygeal pressure ulcers.

In comparison to previous reports [29, 30], this study presents several noteworthy advancements and highlights the novelty of this work. First, while previous studies have investigated the use of antibiotic bone cement or VSD individually for the treatment of sacrococcygeal pressure ulcers, our research is distinct in its evaluation of the combined approach. By utilizing a combination of antibiotic bone cement and VSD, we propose a novel treatment strategy that may offer improved outcomes for patients with these ulcers. Additionally, our study goes beyond the traditional evaluation of clinical data by integrating an analysis of immune function markers and assessing pain relief. Our study provides a more comprehensive understanding of the efficacy of antibiotic bone cement in combination with VSD. Through these contributions, our work paves the way for further advancement in the treatment of sacrococcygeal pressure ulcers.

This study has some limitations that warrant mention. First, as a single center with small sample size, had certain selective biases that cannot be avoided. Secondly, the long-term efficacy and recurrence of sacrococcygeal pressure ulcers in patients was not observed. Future research should aim to expand the study scope by integrating refined care approaches with the current regimen of antibiotic bone cement combined with VSD, extending treatment duration, and enhancing both clinical outcome and patient satisfaction.

The combination of antibiotic bone cement with Vacuum Sealing Drainage (VSD) has demonstrated efficacy in repairing sacrococcygeal pressure ulcers. This treatment approach significantly improves recovery rate, alleviates pain, reduces inflammatory response, and enhances immune function, underscoring its clinical value. However, there are practical challenges in implementation; notably, the hard bone cement beads can rub against surrounding tissues when the patient changes position, causing exudate formation. Clinically, it is crucial to ensure meticulous drainage and regular examinations. Additionally, during surgery, careful attention must be paid to proper fixation and sufficient tissue coverage when implanting antibiotic cement beads to minimize friction and prevent skin irritation.

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Disclosure of conflict of interest

None.

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