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Application of damage control surgery in patients with sacrococcygeal deep decubitus ulcers complicated by sepsis

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Abstract

Objective: To evaluate the clinical application of damage control surgery (DCS) in patients with sacrococcygeal deep decubitus ulcers complicated by sepsis.

Methods: We conducted a 3-year retrospective clinical study of 32 patients with deep sacrococcygeal bedsores and sepsis admitted from January 2018 to January 2021. According to the concept of DCS, the wound was temporarily closed with vacuum sealing drainage after primary debridement, and a local rhomboid flap was designed to repair the wound in the second stage. Finally, the clinical therapeutic effect was observed.

Results: Twenty-nine patients were treated with skin flap translocation and were cured clinically. Specifically, the skin flap survived in 27 of the 29 patients after the first translocation attempt (success rate of 93.1%). One patient developed incisional dehiscence, and one patient developed a hydrocele under the skin flap.

Conclusions: Application of DCS in patients with sacrococcygeal deep decubitus ulcers complicated by sepsis improves the therapeutic success rate and reduces the risks of the operation and complication rate. It has unique advantages and is worthy of clinical promotion.

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Introduction

In recent years, the incidence of pressure sores has been increasing as population aging has intensified. Pressure sores are divided into stage I, II, III, and IV according to their depth. Stages III and IV are considered deep pressure sores.[1] When deep decubitus wounds are not repaired in a timely manner, patients are at higher risk of developing sepsis, which is life-threatening. The mortality rate of decubitus wounds combined with sepsis is as high as 50%.[2] The high incidence rate of sepsis, the rapid progression of disease, and the high mortality rate all make clinical care difficult. In recent years, the application of damage control surgery (DCS) has been becoming increasingly more popular. The concept of DCS is to restore patients' normal physiological state to the greatest degree possible through early and short operations followed by several stages of trauma-specific treatments.[3] From January 2018 to January 2021, we selected 32 consecutive patients with sacrococcygeal deep bedsores complicated by sepsis. The patients recovered well with application of DCS. Specifically, we used vacuum sealing drainage (VSD) to temporarily close the wound after primary debridement and then used a local modified rhomboid skin flap to repair the wound surface as a second-stage procedure. The reporting of this study conforms to the STROBE guidelines.[4]

Data and methods

Patients' backgrounds

From January 2018 to January 2021, 32 patients with sacrococcygeal deep decubitus ulcers complicated by sepsis were admitted to the Burn Department of Quanzhou First Hospital. They comprised 19 male and 13 female patients ranging in age from 14 to 97 years (mean age, 63 years). Eighteen patients had paraplegia, seven had hemiplegia after a cerebrovascular accident, five had senile dementia, and two were bedridden for other causes. The duration of the pressure sores ranged from 1 month to 6 years, with an average of 18 months. All pressure sores were located in the sacral region. According to the pressure sore stages[5] revised and recommended by the National Pressure Ulcer Advisory Panel (NPUAP), 21 patients had stage III ulcers and 11 patients had stage IV. The diameter of the pressure sores ranged from 3.0 to 13.0 cm with a mean of 7.8 ± 2.5 cm, and their depth ranged from 1.2 to 5.0 cm with a mean of 3.5 ± 1.2 cm. The shape of the pressure sore cavity was similar to the shape of a flask with a small opening and flat, wide bottom. Large amounts of purulent secretions and necrotic tissues were present in the cavity. All 31 patients presented with chills, fever, shortness of breath, an increased heart rate, and an elevated white blood cell count. The patients had a 24- to 48-hour Sequential Organ Failure

Assessment score of 2 to 16 (mean of 11), an Acute Physiology and Chronic Health Evaluation II score of 14 to 30 (mean of 23.2), and met the diagnostic criteria for sepsis according to the International Guidelines for Management of Sepsis and Septic Shock: 2016.[6] Pathologic laboratory testing revealed 15 cases of *Escherichia coli* infection, 11 cases of *Enterococcus faecalis* infection, 8 cases of *Staphylococcus aureus* infection, 5 cases of *Pseudomonas aeruginosa* infection, and 3 cases of *Klebsiella pneumoniae* infection. Other critical complications were hypoproteinemia in 32 patients, pulmonary infection in 19, diabetes in 15, hypertension in 11, coronary heart disease in 8, class IV heart failure in 5, hepatic insufficiency in 11, kidney failure in 8, and nephrotic syndrome in 2.

Preoperative treatment

The patients received nutritional support; were treated for hypoalbuminemia; underwent correction of any negative nitrogen balance, anemia, or water–electrolyte disorders; received therapy to maintain the stability of their internal environment; and were treated with antibiotics according to the results of a drug sensitivity test based on the pathologic culture result. For patients with lung infection, hypertension, diabetes mellitus, and liver and kidney dysfunction, treatments were adjusted based on consultation with a specialist. The patients also underwent intestinal preparation to avoid fecal contamination of the wound, and their tolerance of surgery was assessed to complete the preoperative preparation.

Surgical treatment

Anesthesia. An anesthetic technique involving little disturbance to the whole body was adopted to ensure the shortest possible anesthesia time. Fourteen patients underwent paraplegic anesthesia, eight underwent intraspinal anesthesia, and seven underwent general anesthesia.

Stage 1: Primary debridement and VSD therapy

After exploration of the pressure sore, the wound surface or sinus wall was stained with methylene blue, the necrotic skin and fascia were incised, the necrotic cavity was enlarged, and the necrotic, thickened wall and old granulation and scar tissue were thoroughly removed. In 11 patients with stage IV pressure sores, necrotic bone tissue and cancellous bone were removed, no osteomyelitis was found, and the coccyx was preserved. To remove all potentially infected tissue upon debridement, the wound was rinsed repeatedly with 3% hydrogen peroxide solution, normal saline, and 0.1% iodophor solution until the rinsing solution was clear. The concentration of the solution was maintained within a safe range to reduce the wound irritation and injury caused by the hydrogen peroxide and iodophor.

The wound cavity was filled with VSD material, the wound surface was covered by the same VSD material, and a drainage tube was fixed in the VSD dressing. A semipermeable membrane was used to seal the wound surface with the surrounding normal skin. Upon connecting the negative-pressure device, the wound was checked to ensure that the device was airtight and that the drainage was smooth. After the operation, 20 to 40 kPa of negative pressure was used for continuous suction, and normal saline was used for continuous irrigation to keep the wound moist. The average operation time was about 50 minutes, and the average blood loss volume was about 100 mL.

Stage 2: Local modified rhomboid skin flap translocation

A one- or two-sided modified rhomboid fasciocutaneous flap was designed according to the size and shape of the wound. Twenty-four patients with a wound diameter of <10 cm underwent repair with a one-sided modified rhomboid fascia flap, and five patients with a wound diameter of >10 cm or a transverse-to-vertical diameter ratio of >1.5 underwent repair with a two-sided modified rhomboid fascia flap. The predesigned line was followed to cut the skin and subcutaneous tissue to the deep fascia, and the skin flap was lifted. The bleeding was carefully stopped, protecting the blood flow of the pedicle. The skin flap was then rotated to cover the wound, and the opposite side of the skin flap incision was sutured subcutaneously. A negative-pressure silica gel drainage tube was placed, and the incision was sutured in layers. The wound was pressurized and wrapped with sterile dressing. The average operation time was about 70 minutes, and the average blood loss volume was about 120 mL.

Postoperative management

An air-flow suspension bed was used to provide good surface pressure for the skin flap, reduce the shear force, provide uniform pressure to avoid local sites of high pressure or necrosis, and avoid repeated roll-over, which would negatively affect wound healing. The negative-pressure silica gel drainage tube was retained for 2 to 7 days; it was removed when the drainage fluid volume was <10 mL. The postoperative medical care included dilation of blood vessels, improvement of microcirculation, anti-infection therapy, and nutritional support. The flap blood flow, fluid accumulation, and incision were continuously observed. The dressing was changed 24 hours after the operation and once every 2 days thereafter. The sutures were removed 14 days after the operation.

Statistical analysis

Student's paired t test was used to compare infection indexes and organ function indexes before and after treatment. All statistical analyses were performed with IBM SPSS Statistics for Windows, Version 23.0 (IBM Corp., Armonk, NY, USA). The data are presented as mean ± standard deviation. P values of <0.05 were considered statistically significant.

Results

Among the 32 patients, 29 were cured and discharged. The mean length of the hospital stay was 31.2 ± 7.3 days. Two patients of advanced age discontinued treatment, and one of them died of multiple organ dysfunction syndrome. After open reduction, anti-infection therapy, early debridement, and negative-pressure aspiration, the patients' white blood cell count, procalcitonin concentration, and C-reactive protein

Table 1. Comparison of infection indexes before and after treatment.

	n	WBC count (10^9 cells/L)	CRP (mg/L)	PCT (ng/mL)
Day 1	32	23.07 ± 4.98	172.97 ± 22.64	3.65 ± 0.78
Day 10	32	11.18 ± 3.05	27.16 ± 5.36	0.37 ± 0.12
P value		<0.05	<0.05	<0.05

Data are presented as mean ± standard deviation.
WBC, white blood cell; CRP, C-reactive protein; PCT, procalcitonin.

Table 2. Comparison of organ function indexes before and after treatment.

	n	BUN (mol/L)	Cr (μmol/L)	Alb (g/L)	ALT (U/L)	AST (U/L)	TBil (μmol/L)
Day 1	32	9.95 ± 1.00	182.17 ± 36.89	20.47 ± 1.52	143.90 ± 21.48	137.10 ± 19.54	83.90 ± 11.48
Day 10	32	4.68 ± 1.17	76.17 ± 20.16	33.00 ± 1.88	56.77 ± 10.3	31.83 ± 4.49	30.77 ± 8.26
P value		<0.05	<0.05	<0.05	<0.05	<0.05	<0.05

Data are presented as mean ± standard deviation.
BUN, blood urea nitrogen; Cr, creatinine; ALB, albumin; ALT, alanine transaminase; AST, aspartate transaminase; TBil, total bilirubin.

concentration were significantly decreased (Table 1) and their organ function was improved (Table 2). The patients' condition significantly improved from before to after treatment ($P < 0.05$). After the first stage of the operation, the patients underwent continuous rinsing and drainage of the wound by VSD for 7 to 12 days (mean of 10 ± 1.8 days). The wound infection was well controlled, the granulation tissue was fresh, the tissue growth was good, and the wound bed was ready for flap translocation. The success rate was 93.1% (27 cases were cured among 29 cases treated). One patient developed incisional dehiscence, and one developed a hydrocele under the skin flap. The wound was completely closed after the dressing changes. All 29 patients were followed up in 6 to 12 months. The skin flap had a good appearance, good elasticity, good resistance to abrasion and pressure, and had not burst. Scar hyperplasia was not obvious, and the appearance was satisfactory.

Representative case

A 72-year-old man had been bedridden for 1 year due to post-traumatic coma and had developed sacrococcygeal ulceration. Upon admission, his diagnoses were stage IV sacrococcygeal decubitus ulcers, sepsis, pulmonary infection, hypoalbuminemia, type 2 diabetes, and stage 3 hypertension (very high risk).

The patient's sacrococcygeal pressure sore was about 12×8 cm. It was flask-shaped with a small opening and wide bottom, and it invaded the surrounding tissue. A large amount of fascial and muscle necrosis was observed, and the cavity contained a large amount of purulent secretion and necrotic tissue. The wound was deep to the sacral bone (Figure 1(a)–(c)).

In the first stage of treatment, debridement and VSD were performed. The existing cavity was enlarged, and the necrotic and thickened lesion wall were completely removed. All old granulation tissue, scar tissue, and necrotic and infected bone tissue were removed up to the cancellous bone (Figure 1(d)). After debridement, the wound surface was covered with VSD material, and a drainage tube was fixed in the VSD dressing. A semipermeable membrane was used to seal the wound surface with the surrounding normal skin to enable continuous irrigation and drainage after the operation (Figure 1(e), (f)).

Upon removal of the negative-pressure material, the wound infection was found to be well controlled, the granulation tissue was fresh, tissue growth was good, and the wound bed was ready for flap translocation (Figure 1(g)). A modified rhomboid flap was designed to cover the sacral decubitus wound with a subdermal drainage tube (Figure 1(h), (i)). The skin was cut along the predesigned line until reaching the fascial layer to form a fascial flap without damaging the gluteus maximus muscle (Figure 1(j)). The skin flap was then rotated to repair the sacrococcygeal

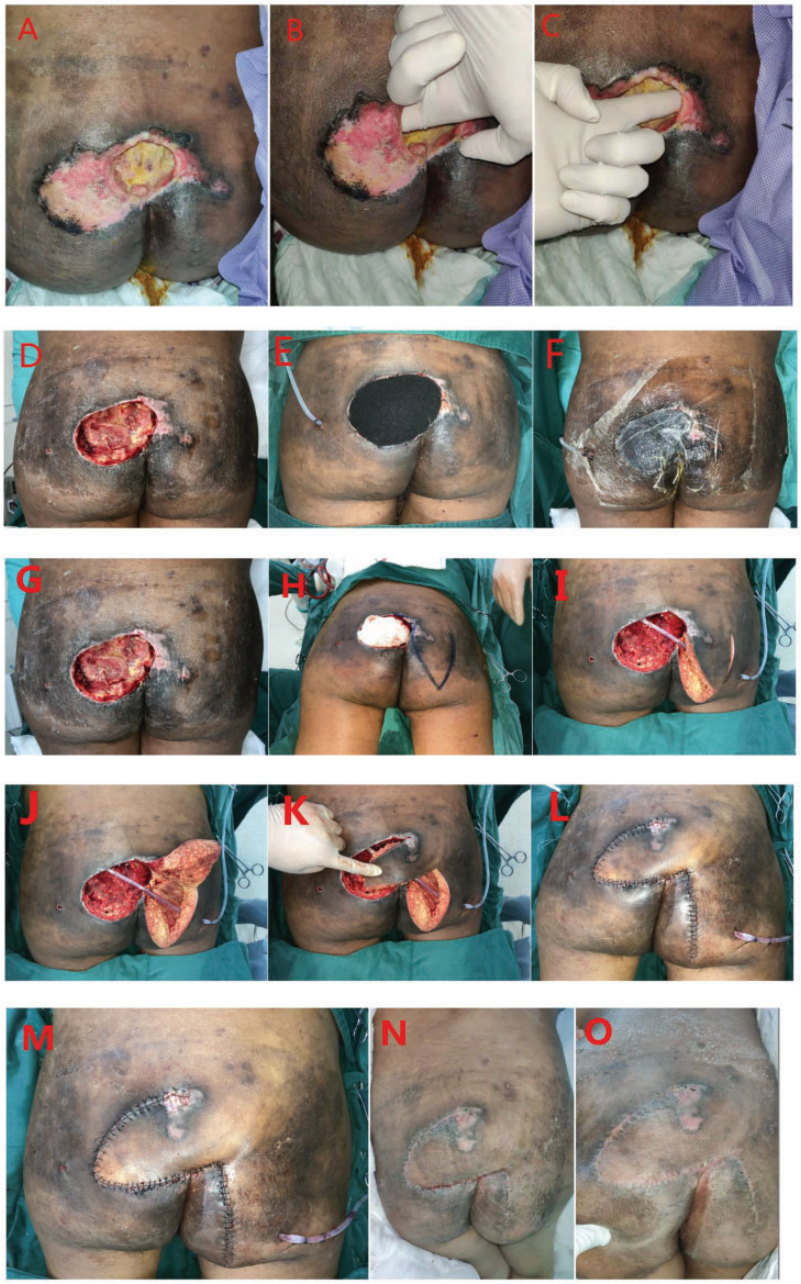

Figure 1. Representative case. (a)–(c) Appearance of sacrococcygeal pressure sore. (d) Debridement and vacuum sealing drainage. (e), (f) Coverage of wound surface with vacuum sealing drainage material and placement of drainage tube. (g) Appearance of wound upon removal of negative-pressure material. (h), (i) Modified rhomboid flap. (j) Incision along predesigned line. (k), (l) Rotation of skin flap and closure of wound. (m) Five-day postoperative appearance of the flap. (n), (o) One- and 12-month postoperative appearance of the flap.

decubitus wound; the tissue was sutured in layers and the wound surface was sealed (Figure 1(k), (l)).

Five days after the operation, the skin flap was rosy in color, the blood circulation was good, and no obvious effusion was present. The skin flap had survived well (Figure 1(m)). At the 1- and 12-month postoperative follow-up visits, the skin flap had a good appearance, was elastic and durable, had good pressure resistance, and had not burst. No obvious scar hyperplasia was present. The patient was satisfied with the overall appearance (Figure 1(n), (o)).

Discussion

The sacrococcygeal region is characterized by protrusion of the sacrococcygeal bone and various other bony structures with little subcutaneous tissue coverage; thus, it is the most common site of pressure sores. Pressure sores in this area are susceptible to becoming damp and contaminated by feces and urine, often resulting in wound infection. This in turn leads to fascia and muscle necrosis and even disruption of the bone. The pathologic bacterial analysis in the present study revealed *Escherichia coli*, *Enterococcus faecalis*, and *S. aureus* infection. These bacteria commonly reside in the gastrointestinal tract and on the skin surface and are able to cause serious infections, even sepsis,[7] when the body's immunity declines or trauma occurs. Patients with pressure sores often have a variety of consumptive diseases such as paraplegia, stroke sequelae, dementia, or coma. Because of the loss of voluntary movement, a long-term bedridden status is often accompanied by pneumonia and thrombosis. Such patients also often have metabolic abnormalities such as diabetes, hypertension, kidney disease, and other basic diseases,[8] all of which are risk factors for sepsis. The complex and variable conditions of these patients place them at high risk for anesthesia and surgery.

DCS was first introduced in the 1990s during wound treatment in the Gulf War. The main goal of DCS is to rapidly repair the anatomical structure of critical injuries and return the patients to a physiologically stable state.[9] After a development period of nearly 30 years, the concept of DCS has been extended into various fields of surgery, such as critical brain injury, thoracoabdominal trauma, and orthopedic trauma, and has achieved good clinical therapeutic results.[10] Once the pathological process of sepsis has begun, the body rapidly develops from systemic inflammatory response syndrome to multiple organ dysfunction syndrome. Therefore, prediction of the occurrence and development of sepsis and interruption of this pathological process will help reduce the incidence and mortality rate of sepsis and multiple organ dysfunction syndrome.

Current guidelines for the treatment of sepsis advocate early surgical removal of the primary infection; this concept is known as "early debridement, delayed suturing."[11] The deep decubitus wounds in the present study contained a large amount of necrotic fascia, muscle, and even bone, and the wounds were severely infected; thus, early and effective debridement was the key to treatment. The wound was enlarged, the necrotic infection focus was removed, the blood circulation was improved, the muscle necrosis was alleviated, the infection was controlled, and finally the occurrence and development of sepsis were blocked.

As the gold standards for assessing infection and sepsis,[12] the white blood cell count, C-reactive protein concentration, and procalcitonin concentration were measured, and all rapidly decreased after debridement. At the same time, the concentrations of blood urea nitrogen, creatinine, aspartate transaminase, alanine transaminase, and

total bilirubin, which reflect kidney function, significantly improved. The function of every organ markedly improved. Many reports worldwide have described the treatment of decubitus ulcers with VSD.[13]

After primary debridement in our study, the sinus and deep cavity were filled with VSD dressing and the surface of the wound was temporarily covered with VSD dressing, which helped to maintain the temperature and humidity of the wound. Continuous negative-pressure suction, irrigation, and drainage helped to remove protease-rich wound exudate, reduce the bacterial count, reduce local tissue edema, and promote fresh granulation tissue growth.[14] The average operation time of the first stage was 50 minutes, which effectively reduced the anesthesia time, operation risk, and operation trauma. The continuous irrigation and drainage after the operation effectively reduced the exudation and controlled the infection. It also provided a good wound bed for wound repair in the later period,[15] which is consistent with the concept of DCS.

The traditional repair method of deep decubitus ulcers is application of a gluteus maximus myocutaneous flap. The nutrient vessels of the gluteus maximus are the superior gluteal artery and inferior gluteal artery. The gluteus maximus muscle is thick and can withstand high pressure, and its use effectively reduces the recurrence rate of pressure sores. However, the muscle, blood vessels, and nerves are easily damaged during the operation, which leads to limitation of the activity of the hip joint. Additionally, if the operation fails or pressure sores recur, a gluteus maximus myocutaneous flap cannot be used to repair the wound, thus increasing the difficulty of treatment.[16] With the development of microsurgery, the use of free skin flaps has been reported in recent years to repair pressure sores, and good results have been achieved. However, the operative wound is large, the operation time is long, the anesthesia risk is high, many postoperative complications may occur, and recovery is slow.

Free skin flaps are also difficult to popularize and apply because of the requirement for high operative skill.[17] The modified rhomboid flap has the advantages of direct design, simple preparation, and a reliable blood supply, and it has been used in the repair of deep pressure ulcer wounds with good outcomes.[18] The modified rhomboid flap maintains the vertical movement of the skin around the wound, increases the movement of the skin, reduces the rotation angle of the flap, reduces the deformity, changes the direction of tension of the incision, shortens the total length of the scar, and improves blood flow.[19] In the present study, 24 patients with a wound diameter of <10 cm underwent repair with a 1-sided modified rhomboid fasciocutaneous flap, and 5 patients with a wound diameter of >10 cm underwent repair with a 2-sided modified rhomboid fasciocutaneous flap. The operation only requires separation of the fascia; the muscle does not need to be separated. Thus, the operation is simple, the wound is small, and the risks of the operation and anesthesia are greatly reduced.

The average operation time in the present study was 70 minutes, which is much shorter than that of the traditional method, effectively reducing the severity of operation-related injury. At the same time, this technique avoids the impact of hip joint movement in the later postoperative period due to muscle separation. This is beneficial for rehabilitation of lower limb function. In the current study 27 of 29 patients achieved primary wound healing with a success rate of 93.1%. If the modified rhomboid flap becomes necrotic or a pressure sore recurs, a local skin flap or musculocutaneous flap can be used to repair the wound because the local muscle and blood vessels are not

damaged.[20] This satisfactory result further confirms the feasibility of using a modified rhomboid flap to repair pressure sore wounds.

Conclusion

When treating deep decubitus ulcers and sepsis according to the concept of DCS, the wound should be temporarily closed with VSD dressing after thorough debridement in stage 1 to remove the focus of necrotic infection, and the wound must be continuously rinsed and drained after the operation. In stage 2, a rhomboid skin flap is modified to repair the deep pressure sore. This strategy may effectively control infection, improve organ function, repair pressure sores in a timely manner, shorten the anesthesia and operation times, and effectively avoid secondary trauma to the patient caused by operative injury; it is thus beneficial for postoperative recovery with reduced complications. It is also consistent with the concept of DCS. Based on the therapeutic outcomes observed in the present study, this scheme may effectively improve the treatment success rate and reduce mortality; it is effective, safe, and worthy of clinical promotion. However, because this was only a small retrospective study, a multicenter, large-sample study is still needed to further improve the treatment regimen.

Ethics approval and consent to participate

This study was approved by the regulations of the Ethics Committee of Quanzhou First Hospital (No. [2018]217). Written consent to publish the representative case report of the 72-year-old patient was obtained from the patient himself in compliance with the regulations of the Ethics Committee of Quanzhou First Hospital. All patients provided written informed consent, and the personal information of the patients has been removed.

Declaration of conflicting interest

The authors declare that there is no conflict of interest.

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References

1. Mervis JS and Phillips TJ. Pressure ulcers: pathophysiology, epidemiology, risk factors, and presentation. *J Am Acad Dermatol* 2019; 81: 881–890. DOI: 10.1016/j.jaad.2018.12.069.
2. Mervis JS and Phillips TJ. Pressure ulcers: prevention and management. *J Am Acad Dermatol* 2019; 81: 893–902. DOI: 10.1016/j.jaad.2018.12.068.
3. Pimentel SK, Rucinski T, Meskau MPA, et al. Damage control surgery: are we losing control over indications? *Rev Col Bras Cir* 2018; 45: e1474. DOI: 10.1590/0100-6991e-20181474.
4. Von Elm E, Altman DG, Egger M, et al. The Strengthening the Reporting of Observational Studies in Epidemiology (STROBE) statement: guidelines for reporting observational studies. *Ann Intern Med* 2007; 147: 573–577.
5. Jeon YT. Avoiding pressure ulcers: beyond proper positioning. *Korean J Anesthesiol* 2018; 71: 1–2. DOI: 10.4097/kjae.2018.71.1.1.
6. Gotts JE and Matthay MA. Sepsis: pathophysiology and clinical management. *BMJ* 2016; 353: i1585. DOI: 10.1136/bmj.i1585.
7. Gencay I. Topical sevoflurane: an alternative treatment for pressure ulcers. *J Coll Physicians Surg Pak* 2019; 29: S92–S94. DOI: 10.29271/jcpsp.2019.12.S92.
8. Saghaleini SH, Dehghan K, Shadvar K, et al. Pressure ulcer and nutrition. *Indian J*

Crit Care Med 2018; 22: 283–289. DOI: 10.4103/ijccm.IJCCM_277_17.
9. Malgras B, Prunet B, Lesaffre X, et al. Damage control: concept and implementation. *J Visc Surg* 2017; 154: S19–S29. DOI: 10.1016/j.jviscsurg.2017.08.012.
10. Waibel BH and Rotondo MMF. Damage control surgery: its evolution over the last 20 years. *Rev Col Bras Cir* 2012; 39: 314–321. DOI: 10.1590/s0100-69912012000400012.
11. Huang M, Cai S and Su J. The pathogenesis of sepsis and potential therapeutic targets. *Int J Mol Sci* 2019; 20: 5376. DOI: 10.3390/ijms20215376.
12. Cui N, Zhang H, Chen Z, et al. Prognostic significance of PCT and CRP evaluation for adult ICU patients with sepsis and septic shock: retrospective analysis of 59 cases. *J Int Med Res* 2019; 47: 1573–1579. DOI: 12.1177/0300060518822404.
13. Zhang F, Gu Y and Wu L. Skin-stretching device promotes the treatment effect of vacuum sealing drainage technique on phases III and IV stress-induced injuries in aged patients with chronic critical illness: a retrospective study of 70 patients. *Medicine (Baltimore)* 2019; 98: e18027. DOI: 10.1097/md.0000000000018027.
14. Lai Y and Yan X. [VSD could effectively manage surgical infection]. *Zhongguo Fei Ai Za Zhi* 2018; 21: 349–350. DOI: 10.3779/j.issn.1009-3419.2018.04.27.
15. Lv Z, Wang Q, Jia R, et al. Pelnac® artificial dermis assisted by vsd for treatment of complex wound with bone/tendon exposed at the foot and ankle, a prospective study. *J Invest Surg* 2020; 33: 636–641. DOI: 10.1080/08941939.2018.1536177.
16. Chou CY, Sun YS, Shih YJ, et al. A descriptive, retrospective study of using an oblique downward-design gluteus maximus myocutaneous flap for reconstruction of ischial pressure ulcers. *Ostomy Wound Manage* 2018; 64: 40–44.
17. Shen YB, Xia M, Ke HW, et al. [Thirty-nine cases of stage 4 pressure ulcers treated by a two-stage method of debridement and skin flap transfer]. *Zhonghua Shao Shang Za Zhi* 2020; 36: 870–872. DOI: 10.3760/cma.j.cn501120-20190729-00318.
18. Imafuku K, Hata H, Yamaguchi Y, et al. Modified Dufourmentel flap, easy to design and tailor to the defect. *J Dermatol* 2017; 44: 68–70. DOI: 10.1111/1346-8138.13568.
19. Huang N, Wen H, Fu J, et al. [The application of modified rhomboid flap in repairing facial skin and soft tissue defect]. *Zhongguo Xiu Fu Chong Jian Wai Ke Za Zhi* 2019; 33: 207–211. DOI: 10.7507/1002-1892.201810020.
20. Mett TR, Boyce MK, Ipaktchi R, et al. [Defect coverage using gluteal flaps]. *Oper Orthop Traumatol* 2018; 30: 236–244. DOI: 10.1007/s00064-018-0549-5.