A new waterproof, breathable, bacteriostatic, low-cost dressing system with a decreased number of dressing changes in primary total hip arthroplasty: a feasibility study

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Research

Keywords: Dressing, Waterproof, Hip arthroplasty, Feasibility

Posted Date: May 25th, 2021

DOI: https://doi.org/10.21203/rs.3.rs-551094/v1

Abstract

Background

Postoperative wound complication is a major risk factor for the development of Periprosthetic joint infection, thus, it is very important to manage surgical wounds. We innovatively invented a new dressing system to reduce the occurrence of postoperative wound complications and improve the quality of life of patients after an total hip arthroplasty. Besides, this study confirmed the clinical safety and feasibility of the newly invented dressing system.

Methods

A total of 120 patients who underwent primary unilateral total hip arthroplasty were enrolled in this study. The data collected included the number of dressing changes, costs of the dressings, postoperative hospital stay, The Visual Analogue Scale (VAS) score, The Harris Hip Score (HHS), ASEPSIS score, The Stony Brook Scar Evaluation Scale (SBSES), wound complications, the frequency of showers and satisfaction. Data were statistically analyzed.

Results

The average number of dressing changes was 0.74 ± 0.46, while the average postoperative hospital stay was 3.67 ± 0.97 days. The average cost of the new dressings throughout a treatment cycle was 57.42 ± 15.18 dollars. The VAS score decreased from 5.63 ± 1.09 before the operation to 0.88 ± 0.54 one month after the operation. The HHS score increased from 70.18 ± 7.84 before the operation to 80.36 ± 4.08 one month after the operation. The results of the four indexes of the ASEPSIS score were all 0. The SBSES score was 3.55 ± 0.61 at two weeks after the operation, and 4.38 ± 0.71 at one month after the operation. No wound complications were recorded until one month after the operation when the satisfaction rate was 92.53 ± 3.62%.

Conclusion

In this study, we have invented a new dressing system for surgical wounds after total hip arthroplasty and confirmed its clinical safety and feasibility.

Trial registration

Chinese Clinical Trial Registry, ChiCTR2000033822. Registered 13 June 2020, http://www.chictr.org.cn/showproj.aspx?proj=54735

Introduction

Total hip arthroplasty is one of the most common orthopedic procedures, and as the population ages, the incidence increases every year. Studies report that among patients undergoing total hip arthroplasty, the incidence of periprosthetic joint infection (PJI) ranges between 0.59% and 2%(1, 2). As the number of joint replacements increases over time, so does the number of PJI(3, 4). PJI is the most serious complication of joint replacement, and it is also a major cause of failure for both primary and revision hip arthroplasty(5). Successful treatment requires a complex and long treatment process, therefore, this causes physical, emotional, and economic losses to patients, hospitals, and the health care system(6). Numerous risk factors for PJI are reported in the literature, including advanced age, malnutrition, obesity, diabetes, smoking, superficial wound complications, etc(7, 8). Another major risk factor is superficial wound complications, indicating that proper wound care is essential for the prevention of PJI. Currently, the traditional dressing using aseptic gauze and plastic tape is used after orthopedic surgery. In some cases, wound complications such as erythema and blisters have been observed, resulting in an increased risk of wound pain and infection. Therefore, the traditional gauze dressing is not an ideal dressing for hip arthroplasty.

Calcium alginate dressing, as a new type of wound dressing, has a fast and strong ability to absorb exudates at 17–20 times of their weight, and can effectively control exudation, thus prolonging the dressing change time(9). Besides, it forms a gel and keeps the wound moist, and can also release calcium ions to promote hemostasis and inhibit bacterial growth(10). Studies have shown that moist wounds heal faster and have less pain(11). Thus, calcium alginate dressing has good application prospects. Currently, calcium alginate dressings are often used in combination with gauze dressings. However, this cannot overcome the shortcomings of gauze dressings, and also limits the advantages of calcium alginate dressings, such as prolonging the time of dressing change.

To solve this clinical problem, we innovatively used IV3000 film and calcium alginate dressing in surgical incision management of patients undergoing hip arthroplasty. IV3000 film is a kind of dressing film for intravenous catheterization, with high moisture permeability(12), good waterproof performance, inhibits bacterial colonization(13), has good skin adhesion, no friction with the skin, and almost no pain at removal(14). The combined use of the two not only makes use of the advantages of a calcium alginate dressing in promoting incision healing and absorbing incision exudate, but also makes use of the characteristics of IV3000 film, such as breathable and waterproof, good skin adhesion, and skin-friendly type. Therefore, the current study presents a new waterproof, breathable, and almost free of dressing change dressing system. At the same time, this dressing system is of low cost and suitable for popularization and use in a large area.

This clinical trial was designed to confirm the clinical safety and feasibility of the new dressing system. The trial was evaluated by recording the number of postoperative dressing changes, postoperative hospitalization days and medical costs, wound complications and healing, functional recovery and quality of life of patients, the frequency of showers and self-evaluation of patients' satisfaction.

Patients And Methods

The study was approved by The Medical Ethics Committee of Xiangya Hospital of Central South University and written informed consent was obtained from all the patients. The study was registered at www.chictr.org.cn (ChiCTR2000033822).

The inclusion criteria of patients were as follows: 1. Aged 18 to 85 years old, 2. osteoarthritis and osteonecrosis of the femoral head were diagnosed by physical examination and imaging data, 3. The patient was to undergo primary unilateral total hip arthroplasty. Patients who previously had joint surgery on any hip joint, have obvious scars on any hip joint, suffer from skin diseases such as psoriasis, eczema, or dermatitis, and those who cannot complete regular follow-up were excluded from the study.

Between June 20, 2020, and November 20, 2020, a total of 120 patients were enrolled in the study. There were 59 males and 61 females, with a median age of 57.17±12.86 years old (range 21-75 years old). All the operations were performed by an experienced joint surgeon. The operation was performed using a standard posterolateral approach and the prostheses were all biological.

Application of the New dressing system

Prophylactic antibiotic cefoxitin was routinely used 30min before the operation. The standard three-layer continuous suture method was used in all patients during the operation. The articular capsule was sutured continuously with 2# absorbable knot-free unidirectional barb suture (Quill, Surgical Specialties Corporation, New York, USA), subcutaneous tissue was sutured with 0# absorbable knot-free bi-directional barb suture (Quill, Surgical Specialties Corporation, New York, USA), and intradermal was sutured with 3-0 absorbable knot-free bi-directional barb suture (Quill, Surgical Specialties Corporation, New York, USA). The usage of the new dressing system: 1. After the surgical incision was sutured, 10 cm of skin around the incision was thoroughly de-iodinated with 75% alcohol (Figure 1A). 2. The calcium alginate dressing (Algisite M, Smith & Nephew, London, UK) was folded into three layers in the direction of the long axis and properly cut to a length range slightly longer than the surgical incision of 1cm at both ends (Figure 1B, C). 3. based on the length of the incision, three to four IV3000 films (Smith&Nephew, London, UK) were selected and applied in the direction from the distal end to the proximal end of the limb. The two ends of the film were slightly longer than the incision by about 4cm, and the latter film was overlapped and the previous one was about one cm (Figure 1E, F, G). There were no air bubbles between the films and the skin, and they stuck closely to the skin (Figure 1H). After the operation, all patients adopted the same nursing measures: routine application of prophylactic antibiotic cefoxitin for three days, and subcutaneous injection of enoxaparin sodium 4000IU to prevent deep venous thrombosis. Patients with the new dressing system did not need to change their dressings if there was no obvious large amount of exudation, no scratches, or crimps, and two weeks after the operation, the dressing would be removed. Patients were able to shower normally after the operation (Figure 1I).

Data collection

Data were collected in four parts: the number of dressing changes and cost of dressings, pain and function scores, wound scores and complications, and shower frequency and satisfaction.

The number of dressing changes and cost of dressings

Patients were discharged only when they met stringent standards, including the ability to perform independent personal care, walk at least 70 meters on crutches, get in and out of bed and get up from chairs, and were managed with oral pain relief(15). The postoperative hospital stay was also recorded and calculated as the whole day, and the part less than one day was considered as one day. After discharge, the patients were assigned to a chat group to take photos and upload and evaluate the dressing under the guidance of the medical staff. Two weeks after the operation, all patients were not covered with a dressing, the wound was wiped with 75% alcohol for three days, and the total number of dressing changes were recorded. Besides, the medical expenses incurred by patients using the new dressings were recorded to understand the average cost of the new dressings throughout the treatment cycle.

Pain and function score

The Visual Analogue Scale (VAS) score, The Harris Hip Score (HHS) were used to record the pain and function of patients, and to evaluate the perioperative changes. VAS score(16) is a one-dimensional measurement of pain intensity, which is widely used in different adult populations. The VAS score was used to record pain and is a horizontal line of fixed length, 100mm. The end is defined as the limit of pain to be measured, from left (0) to right (10). HHS(17) was developed to evaluate the results of hip surgery and to evaluate various hip disabilities and treatments in the adult population. HHS assesses pain, function, deformity, and range of activity and each project has a unique digital scale. The highest score for HHS is 100. The higher the HHS, the less the dysfunction. The time point of the evaluation was recorded within one week before the operation, and one month after the operation.

Wound score and complications

ASEPSIS score is a commonly used wound assessment score(18), which consists of an objective wound assessment section, a section on wound treatment, and a section on the consequences of infection. The objective wound assessment part of the ASEPSIS score (19)was used in the current study because the intentions were to only evaluate the clinical appearance of the wound. SBSES score, proposed by Singer et al in 2007(20), is a wound evaluation scale used to measure the cosmetic effect of a wound, including the width, height, color, suture marks, and overall view of the scar. The score of each index is 0 or 1, and the total score is calculated, ranging from 0 (worst) to 5 (best). The ASEPSIS score and the SBSES score were recorded at seven days and one month after the operation. Follow-up was based on the photos taken or on-site observation records. At the same time, the wound complications of the patients in each period were recorded and photographed within one month after the operation.

Shower frequency and satisfaction

A questionnaire was developed to conduct the shower frequency and satisfaction survey. One month after the operation, the patients filled the questionnaire based on their actual situation. The questionnaire recorded patients' satisfaction based on eight parameters, including their comfort with dressings, ability to take a shower, pain treatment, doctor visits, length of stay, number of dressing changes, hospitalization costs, and satisfaction with the overall experience. The parameters were all measured in numerical terms, with a score of 0 to 10, and a maximum score of 80.

Data were collected by one of the researchers who was not directly involved in either the experimental design or surgery.

All quantitative data were expressed as mean ±standard deviation. A paired t-test was used to compare the two groups. $P < 0.05$, was considered to be statistically significant. SPSS25.0 software (SPSS, USA) was used to perform statistical analysis.

Results

1. **The number of dressing changes and cost of dressings**

The average number of dressing changes was 0.74 ± 0.46, and the average postoperative hospital stay was 3.67 ± 0.97 days. The application of the new dressing system required an average of 1 calcium alginate dressing and three IV3000 films, and the calculated cost of one dressing change was 33 dollars. The average cost of the new dressings throughout a treatment cycle was 57.42 ± 15.18 dollars.

2. **Pain and function score**

VAS, and HHS were used to record the pain, and function of the patients, and the evaluation time was set within seven days before the operation, and one month after the operation. The VAS score decreased from 5.63 ± 1.09 before the operation to 0.88 ± 0.54 one month after the operation. The HHS score increased from 70.18 ± 7.84 before the operation to 80.36 ± 4.08 one month after the operation. (Table 1).

Table 1
The score results of VAS, HHS

Variable	Preoperative	One month postoperatively	*P* value
VAS	5.63 ± 1.09	0.88 ± 0.54	< 0.001
HHS	70.18 ± 7.84	80.36 ± 4.08	< 0.001
VAS: Visual Analogue Scale; HHS: The Harris Hip Score.			

3. **Wound score and complications**

During the use of the new dressing system, normal bathing did not affect the dressing, and the waterproof performance was good. The results of serous discharge, erythema, purulent discharge, and wound defect defined by the ASEPSIS score were all 0 (Table 2). The SBSES score was 3.55 ± 0.61 at two

weeks after the operation and 4.38 ± 0.71 at one month after the operation (Table 2). The wound appearance gradually improved with the prolongation of recovery time. No wound complications were recorded until one month after the operation. The wounds healed well and the patients described their scars as comfortable and satisfactory in appearance (Fig. 2).

Table 2
The score results of the ASEPSIS and SBSES

	Two weeks postoperatively	One month postoperatively	*P* value
ASEPSIS	0	0	1.000
Serous discharge	0	0	1.000
Erythema	0	0	1.000
Purulent discharge	0	0	1.000
Wound defect	0	0	1.000
SBSES	0	0	1.000
Width	0.69 ± 0.46	0.81 ± 0.40	0.057
Height	0.88 ± 0.33	0.90 ± 0.30	0.640
Color	0.06 ± 0.24	0.69 ± 0.46	< 0.001
Suture marks	1.00 ± 0.00	1.00 ± 0.00	1.000
The overall view	0.95 ± 0.22	1.00 ± 0.00	0.025
Total score	3.55 ± 0.61	4.38 ± 0.71	< 0.001
SBSES: Stony Brook Scar Evaluation Scale.			

4. **Shower frequency and satisfaction**

According to the questionnaire results, the patient's shower frequency was shown in Table 3, 10 patients (8.33%) did not take showers because they were afraid of getting wound infections. Most patients (95/120, 79.17%) took showers once per day. And the satisfaction score was 73.86 ± 2.81, the full score was 80, and the satisfaction rate was 92.53 ± 3.62%.

Table 3
The results of the shower frequency

Frequency	Number	n%
No shower	10	8.33%
Twice per day	5	4.17%
Once per day	95	79.17%
Every 2 days	7	5.83%
Every 3 days	2	1.67%
Every 4 days	1	0.83%

Discussion

This study confirms the safety and feasibility of a new dressing system for use in primary total hip arthroplasty. During the follow-up to one month after the operation, all the patients did not have any wound complications, the wound healed well and the appearance was satisfactory. Besides, the clinical operation was simple, the number of dressing changes was significantly reduced, and the burden on patients and medical staff was reduced. Thus the new dressing was simple, portable, waterproof, and convenient to the life of patients after the operation.

PJI is a serious complication of joint replacement surgery and causes serious medical and economic burden to patients and society. PJI treatment requires multiple revision surgeries, and the long use of antibiotics does not guarantee that the infection will be eradicated. Previous studies(3, 7, 8, 11) show that complications of the surgical wound are a major risk factor for PJI, thus, the management of surgical wounds is very important. Compared with other surgical wounds, the surgical wound of the hip joint is highly particular; first, the wound of hip arthroplasty may exudate more, accompanied by persistent dressing leakage. Therefore, an ideal dressing should be able to handle excessive exudates while maintaining a barrier to prevent bacteria entry(21). Second, since lower limb joint replacement is usually performed among the elderly with fragile skin, there are increased chances of wound complications, such as blisters and skin injuries(22). Third, since the wounds are located above the joint, the dressing should be allowed to move freely and be able to adapt to changes in the size of the wound accompanied by flexion. Fourth, because of the implanted prosthesis, any wound complications (such as blisters) that damage skin integrity should be avoided to prevent PJI(23).

Considering the particularity of the wound after hip arthroplasty, a combination of the gauze and adhesive tape, which is widely used in our hospital is not appropriate. First, the absorption effect of the exudate by the gauze dressing is not good, and it is easy to soak, and this increases the frequency of dressing change. The constant change in wound dressing allows the wound to contact the outside air, the exudate cannot be absorbed in time and increases the probability of bacteria growth. These are all risk

factors for wound infection. Second, gauze dressings often adhere to the wound after wetting, causing skin damage and pain during wound dressing change. Third, the surface of the gauze dressing is rough and inelastic, and multi-layer coverage can cause bloated wounds. During postoperative hip movement rehabilitation exercise, this may cause obstacles and constant friction which also causes blisters. Fourth, gauze dressings are usually not waterproof, therefore, patients are likely to experience difficulties in having a normal bath and skin cleaning after the operation. Failure to clean the skin well, especially the skin around the wound, can increase the risk of postoperative infection.

To overcome the shortcomings of using gauze dressings, numerous new dressings have emerged. First, incision negative pressure wound therapy (NPWT) (24)has been widely used in open wounds. Recently, some scholars used NPWT in closed surgical wound management, which effectively reduces the incidence of surgical incision complications in high-risk patients. However, at the same time, there were unexpected blisters, and this therapy is expensive and difficult to popularize. The Ag ion dressing(25) has been proven to be effective in promoting wound healing and preventing bacterial colonization infection, even though the high cost is a major obstacle to its wide application. In contrast, calcium alginate dressing has more prospects for popularization and application, and has the advantages of strong absorption capacity of exudates, promotes wound healing, inhibits bacterial growth, prevents bleeding, and reduced cost compared with other new dressings. However, calcium alginate dressings are often used in conjunction with gauze dressings, which not only overcomes the shortcomings of gauze dressings but also limits the advantages of calcium alginate dressings. Therefore, in this study, we combined IV3000 film with calcium alginate dressing as a new dressing system, which not only provides the advantages of calcium alginate dressing, but also increases the advantages of waterproof bathing, good fit with the skin, and limited elasticity. The average cost of the new dressings throughout a treatment cycle was 57.42 ± 15.18 dollars, which is lower compared with that of other new dressings and is comparable to the traditional gauze dressings. However, the average number of dressing changes was 0.74 times, which significantly reduced the number of dressing changes. Some scholars(26) have reported that if the dressing is not often disturbed, the risk of infection is reduced, and the wound dressing maintains the wound near the core body temperature, which helps the healing process. In a clean wound, the incision has a regular edge, the wound usually closes within 48 hours, and fewer dressing changes can protect the wound from repeated exposure to pathogens in the surrounding air, reducing the incidence of PJI. The new dressing system is simple and portable, does not cause pain when changing the dressings, has a beautiful appearance, and has elastic changes with flexion and extension during postoperative exercise, which does not hinder rehabilitation activities. More importantly, taking advantage of the waterproof and breathable properties of the IV3000 film, patients can take a shower normally after the operation, which is of great significance. Patients are required to prepare the skin regularly and take a shower the day before the operation, which significantly reduces the risk of bacterial infection in the skin around the surgical incision. Similarly, it is also important to take a shower and wash the skin after the operation, which cannot be achieved with gauze dressing but is achieved with the new dressing system. Normal shower after the operation not only cleans the skin around the wound, reduces

bacterial colonization, reduces the risk of wound infection, but also improves the quality of life of patients after the operation, and patient satisfaction.

ASEPSIS score and SBSES score were used to evaluate wound healing and possible wound complications. The results showed that there were no wound complications one month after the operation, and the wound healed well based on the objective score of the wound. The SBSES scored highly in the evaluation of the appearance of the wound, and the patients reported the satisfactory appearance of the wound scar. The satisfaction survey showed that the patients' satisfaction rate was more than 90%, indicating that the new dressing system is very popular with patients.

In this study, the results confirm the clinical safety and feasibility of the new dressing system for the wound after total hip arthroplasty. The new dressing system has various advantages, including a reduced number of dressing changes, waterproof and breathable, bacteriostatic, and of low cost. However, these advantages need to be verified using a larger sample size in clinical randomized controlled trials which are underway.

Conclusion

In this study, we have invented a new dressing system for surgical wounds after total hip arthroplasty. By combining IV3000 films and calcium alginate dressing, we have creatively invented a dressing system that promotes incision healing, bacteriostatic, absorbs incision exudates, breathable and waterproof, and has good skin adhesion. This prospective feasibility study confirms the clinical safety of the new dressing system.

Abbreviations

PJI
Periprosthetic joint infection
VAS
Visual Analogue Scale
HHS
Harris Hip Score
SBSES
Stony Brook Scar Evaluation Scale
NPWT
Negative pressure wound therapy

Declarations

Ethics approval and consent to participate:

The study design was approved by The Medical Ethics Committee of Xiangya Hospital of Central South University (No.202010128) and informed consent was obtained from the patient in the study.

Consent for publication:

Availability of data and materials:

The datasets used and/or analysed during the current study are available from the corresponding author on reasonable request.

Competing interests:

The authors declare that they have no competing interests.

Funding:

This study was supported by National Natural Sciences Foundation of China (Grant No. 81974360 and 81902308).

Author contributions:

DZ, YH, and PL conceived the original ideas of this manuscript. SS, CW, and FG executed the follow-up examination and materials collection. DZ, YH, and PL read the examination results, participated in the surgical and medical treatment. SS prepared the figures. PL and SS prepared the manuscript.

Acknowledgements:

Not applicable.

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Figures

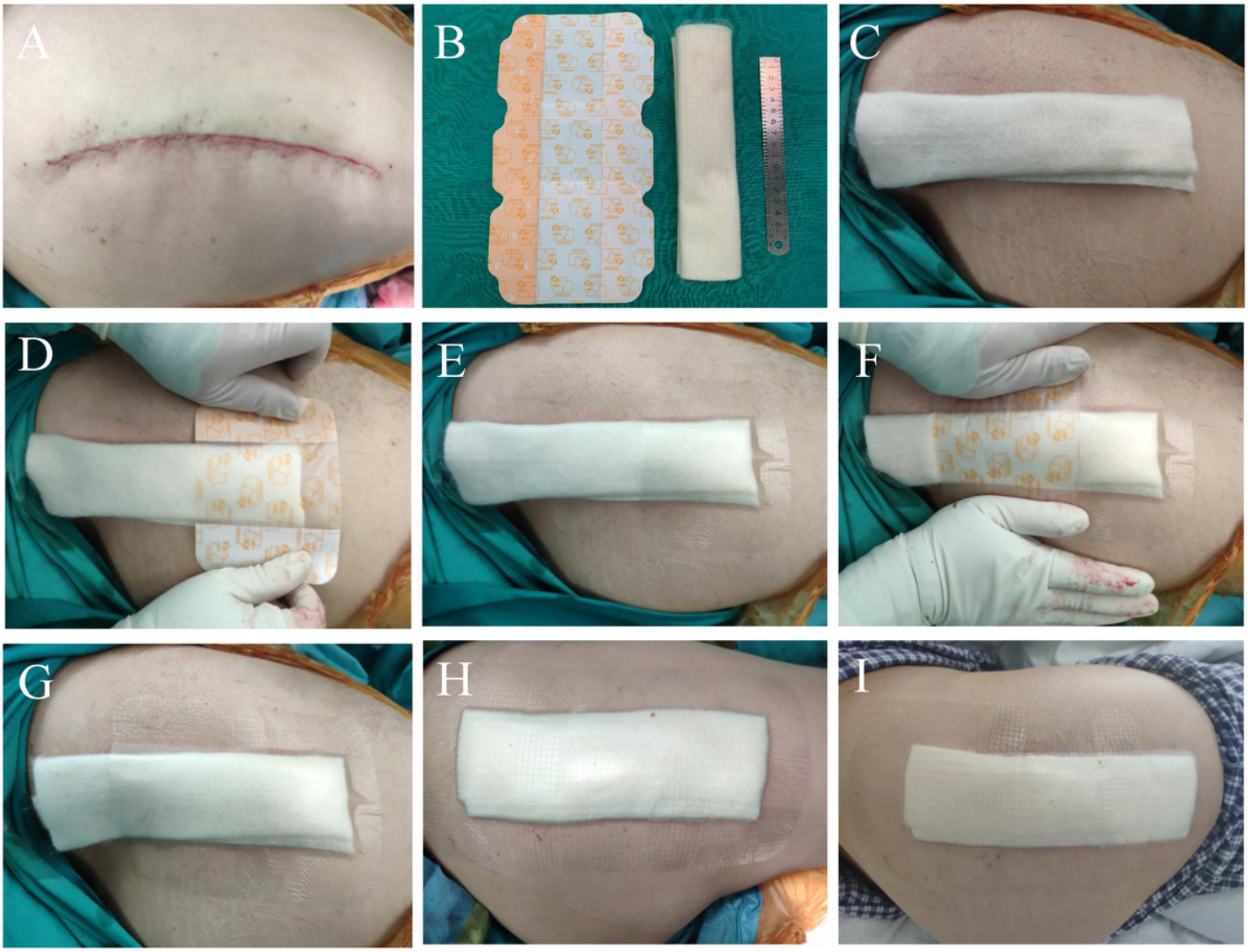

Figure 1

A. The wound was sutured and deiodized. B. Folded calcium alginate dressing and three IV3000 films. C. Cut the calcium alginate dressing to both ends slightly longer than the incision 1cm. D-H. According to the length of the incision, three IV3000 films were selected and applied in the order from the distal end to the proximal end of the limb. The two ends of the film were slightly longer than the incision about 4cm, and the latter film was overlapped and the previous one was about 1cm. There are no air bubbles between the films, and the skin and stick closely to the skin. I. After the patient took a bath according to his own habits, the dressing was not affected.

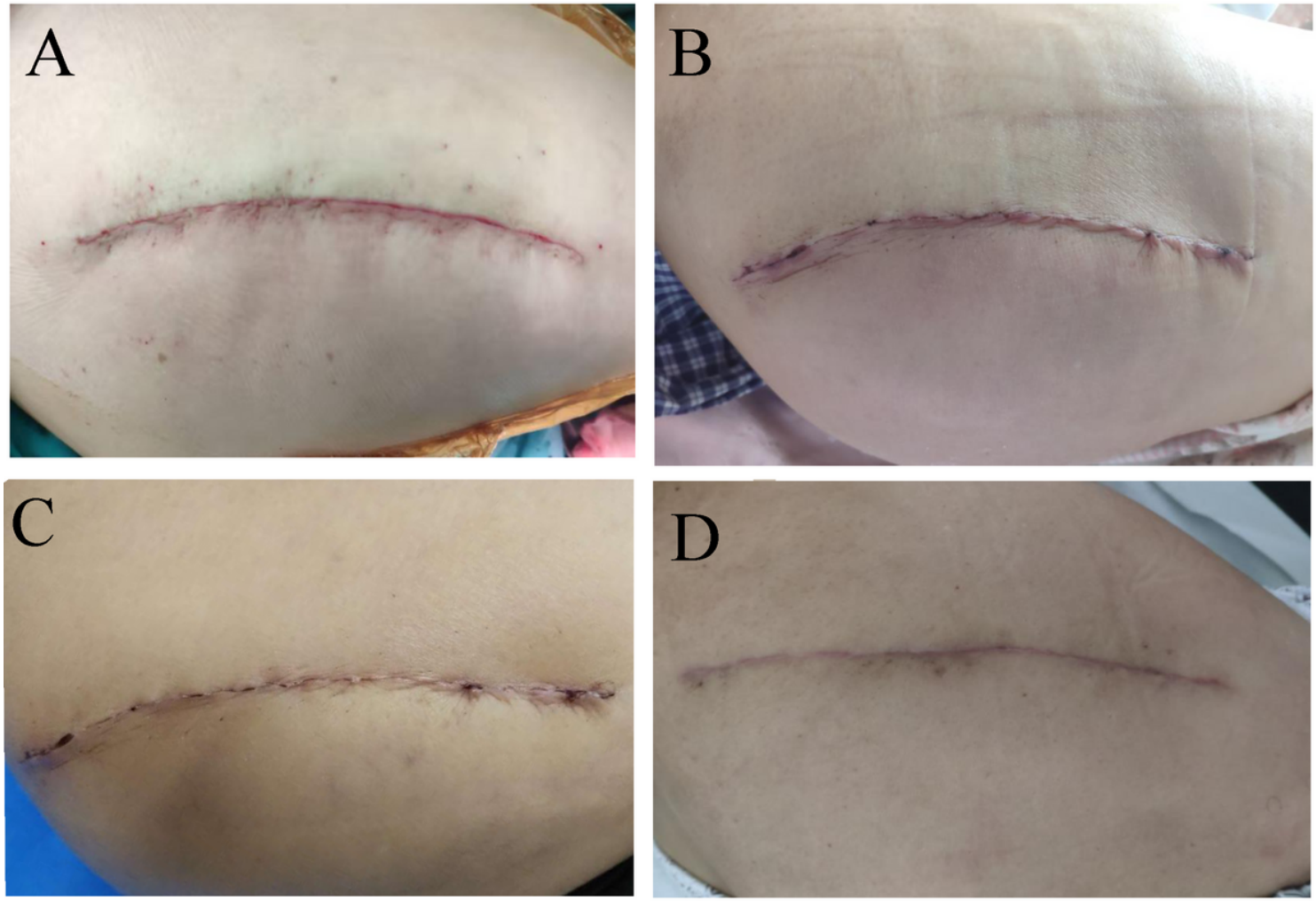

Figure 2

A. Shows wound sutured during the operation. B. There was no obvious ecchymosis, swelling, and exudation in the wound three days after the operation. C. The wound healed completely two weeks after the operation. D. One month after the operation, the wound of the patient showed that the scar was smooth, consistent with the color of the surrounding skin, and the overall appearance was satisfactory.