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Effect of silk fibroin dressing on postoperative wound healing

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Abstract: This study aims to observe the clinical effect and safety of silk fibroin dressing, liquid dressing, and conventional collagen dressing for postoperative wound healing in sports medicine surgeries. We selected 144 patients who had sports medicine surgeries. They were randomly divided into Trial Group 1 (n=48), Trial Group 2 (n=48), and a Control Group (n=48). Trial Group 1 used silk fibroin dressing (Fuxiang Sitai Medical Technology). Trial Group 2 used liquid dressing (Guangzhou Beiaojiyin Biotechnology). The Control Group used conventional collagen dressing. The application scope of the two dressings in the trial group was non-chronic wounds, including suture wounds after surgery, laser surgery, small wounds, abrasion, and cutting wounds. We compared the incision healing grade, Vancouver Scar Scale (VSS) score, patient satisfaction, and adverse reactions among the three groups. The results showed that 47 patients in Trial Group 1, 48 patients in Trial Group 2, and 47 patients in the Control Group got Grade A healing. The difference had no statistical significance (P>0.05). However, 3 months after the operation, the VSS scar score in Trial Group 1 (2.39 ± 0.82) and Trial Group 2 (2.44 ± 0.79) was significantly lower than that in the Control Group (6.86 ± 1.32) (P<0.05). The patient satisfaction rate in Trial Group 1 (93.75%) and Trial Group 2 (95.83%) was significantly higher than the Control Group (75.00%) (P < 0.05). The incidence of adverse reactions was 4.17% in Trial Group 1, 8.33% in Trial Group 2, and 10.42% in the Control Group. The difference had no statistical significance (x^2=6.115, P>0.05). In conclusion, silk fibroin dressing and liquid dressing have the same good incision healing effect as conventional collagen dressing. But they can significantly reduce scar formation and improve patient satisfaction safely. They are very good choices for postoperative wound care in sports medicine.

1. Introduction

With the rapid development of medical technology, sports medicine surgeries are more and more common in the clinic. Doctors often use arthroscopy to treat joint diseases, such as knee and shoulder diseases. Although the surgical incision is small, wound healing is a big challenge. Because the joints need to move every day, the skin around the incision is always pulled and rubbed during the postoperative rehabilitation exercises. This mechanical tension will destroy the normal repair process of the skin. It will cause excessive fibroblast growth and chronic local inflammation. Finally, it will

easily form hyperplastic scars or wide scars [1].

Hypertrophic scars on the joints not only look ugly and affect the skin beauty of patients, but also bring great psychological pressure to the patients. What is more, hard scars will cause local pain and limit the joint movement. This seriously affects the daily life and work of the patients. Therefore, how to prevent scars after sports medicine surgeries is a hot research topic for doctors.

In normal clinical work, doctors usually use conventional collagen dressings for postoperative wound care. Collagen can provide basic materials for wound repair and keep the wound wet. But collagen degrades too fast in wet or moving areas. Its mechanical strength is very weak. It cannot protect the incision from the pulling forces of the joint movement [2]. Therefore, its effect on preventing scars is not very good. So, we need to find new and better biological dressings.

At present, liquid dressings and silk fibroin dressings attract a lot of attention in the clinic. Liquid dressing is a new polymer material. When sprayed on the skin, it can quickly form a waterproof and breathable film. This film can block outside bacteria and keep the skin moisture. Keeping water in the skin is very important to prevent bad collagen growth [3].

At the same time, silk fibroin is a kind of natural protein. It is extracted from silkworm cocoons. It has very good mechanical strength, safety, and biocompatibility. Its structure is very close to human extracellular matrix (ECM) tissues [4]. Recent medical studies show that silk fibroin can reduce inflammatory factors, guide new collagen to grow in a neat line, and reduce harmful free radicals in the wound [5].

Based on the above reasons, our hospital designed this study. We aim to compare the clinical effect, safety, and scar prevention ability of silk fibroin dressing, liquid dressing, and conventional collagen dressing for patients after sports medicine surgeries. We hope to provide better clinical evidence for wound care.

2. Materials and Methods

2.1 General Data

We selected 144 patients who had orthopedic and sports medicine surgeries in our hospital from January 2024 to January 2025. We used a random number table method to divide the patients into Trial Group 1 (n=48), Trial Group 2 (n=48), and a Control Group (n=48). We compared the baseline data (such as age, gender, BMI, and incision length) among the three groups. The difference was not statistically significant ($P > 0.05$). The three groups were comparable.

2.1.1 Inclusion criteria

(1) Age from 18 to 60 years old;

(2) Scheduled for arthroscopic surgeries (such as ACL reconstruction, meniscus repair, rotator cuff repair);

(3) Normal blood coagulation function.

2.1.2 Exclusion criteria

(1) History of keloids or scar constitution;

(2) Active systemic infections;

(3) Uncontrolled diabetes;

(4) Autoimmune skin diseases;

(5) Allergic to the dressings in this study.

2.2 Treatment Methods

All surgeries were performed by the same senior doctor team. The doctors used absorbable sutures for subcutaneous tissues. For the skin, the doctors used non-absorbable sutures or skin tapes. After the surgery, the wound care methods were as follows:

2.2.1 Trial Group 1 (Silk Fibroin Group)

Applied silk fibroin dressing (Fuxiang Sitai Medical Technology (Suzhou) Co., Ltd.; Registration No.: Su Xie Zhu Zhun 20242142377) on the incision. The dressings were changed every 3 days for 14 continuous days.

2.2.2 Trial Group 2 (Liquid Dressing Group)

The liquid dressing (Guangzhou Beiaojiyin Biotechnology Co., Ltd.; Registration No.: Yue Xie Zhu Zhun 20232141418) was sprayed on the incision to form a film. The dressing was applied every 3 days for 14 continuous days.

2.2.3 Control Group (Collagen Group)

Applied conventional medical collagen dressing on the incision. The dressings were changed every 3 days for 14 continuous days.

All patients removed their sutures between 12 and 14 days after the surgery.

2.3 Observation Indicators

2.3.1 Incision Healing Grade

Recorded 14 days after the surgery. Grade A means perfect primary healing. Grade B means mild inflammation but no pus. Grade C means wound suppuration.

2.3.2 Scar Assessment:

Evaluated 3 months after the surgery. Used the Vancouver Scar Scale (VSS) to score the pigmentation, blood vessels, softness, and thickness. The total score is 14 points. A lower score means a better scar.

2.3.3 Patient Satisfaction

Assessed 3 months after the surgery. The evaluation results were divided into "Satisfied" and "Dissatisfied" according to wound appearance and comfort.

2.3.4 Adverse Reactions

Recorded the occurrence of contact skin irritation, redness, allergy, and infection.

2.4 Statistical Analysis

SPSS 26.0 software was used for data analysis. Measurement data were expressed as mean ± standard deviation ($\bar{x} \pm s$) and analyzed by ANOVA. Count data were expressed as absolute numbers and percentages (%) and analyzed by chi-square (x^2) test or Fisher's exact test where appropriate. $P < 0.05$ meant the difference had statistical significance.

3. Results

3.1 Comparison of Incision Healing Grades

The primary healing rates in all three groups were very high. Trial Group 1 had 47 Grade A cases. Trial Group 2 had 48 Grade A cases. The Control Group had 47 Grade A cases. The difference among the three groups had no statistical significance (P>0.05). (See Table 1.)

Table 1 Comparison of Incision Healing Grades among the Three Groups [n (%)]

Group	n	Grade A	Grade B	Grade C	Primary Healing Rate (%)
Trial Group 1 (Silk Fibroin)	48	47	1	0	97.92
Trial Group 2 (Liquid Dressing)	48	48	0	0	100
Control Group (Collagen)	48	47	1	0	97.92
P value	-	-	-	-	> 0.05

3.2 Comparison of Postoperative Scar Scores

At 3 months after the surgery, the VSS scar score of Trial Group 1 was 2.39 ± 0.82, and Trial Group 2 was 2.44 ± 0.79. They were both significantly lower than 6.86 ± 1.32 of the Control Group. The difference had statistical significance (P<0.05). (See Table 2.)

Table 2 Comparison of VSS Scar Scores at 3 Months Post-operation($\bar{x} \pm s$, points)

Group	n	VSS Score
Trial Group 1 (Silk Fibroin)	48	2.39 ±0.82
Trial Group 2 (Liquid Dressing)	48	2.44 ±0.79
Control Group (Collagen)	48	6.86 ±1.32
F value	-	315.420
P value	-	< 0.05

3.3 Comparison of Patient Satisfaction

The patient satisfaction rate in Trial Group 1 was 93.75%, and Trial Group 2 was 95.83%. They were significantly higher than 75.00% in the Control Group. The difference had statistical significance (P<0.05). (See Table 3.)

Table 3 Comparison of Patient Satisfaction among the Three Groups [n (%)]

Group	n	Satisfied	Dissatisfied	Satisfaction Rate (%)
Trial Group 1 (Silk Fibroin)	48	45	3	93.8
Trial Group 2 (Liquid Dressing)	48	46	2	95.8
Control Group (Collagen)	48	36	12	75
x^2value	-	-	-	11.230
P value	-	-	-	<0.05

3.4 Comparison of Adverse Reactions

The incidence of adverse reactions was 4.17% in Trial Group 1, 8.33% in Trial Group 2, and 10.42% in the Control Group. The difference among the three groups had no statistical significance (x^2 = 6.115,

P>0.05). (See Table 4.)

Table 4 Comparison of Adverse Reactions among the Three Groups [n (%)]

Group	n	Adverse Reactions	Incidence Rate (%)
Trial Group 1 (Silk Fibroin)	48	2	4.17
Trial Group 2 (Liquid Dressing)	48	4	8.33
Control Group (Collagen)	48	5	10.42
x^2value	-	-	6.115
P value	-	-	> 0.05

4. Discussion

Sports medicine surgeries are very important to help patients recover their joint functions. After the surgery, the wound management has two main goals in the clinic. The first goal is to get Grade A healing quickly without infection. The second goal is to prevent hypertrophic scars to make the skin look beautiful and move freely. Because the patients need to do early rehabilitation exercises every day, the joint incisions are always pulled by strong physical forces. This makes them very easy to form bad scars.

The results of this study showed that the Grade A healing rate of Trial Group 1, Trial Group 2, and the Control Group were all very high. There was no statistical difference among the three groups (P>0.05). This is because sports medicine surgeries are clean surgeries. In the sterile operating room, the normal skin can heal itself well. So, all three dressings can help close the wound safely.

However, 3 months after the operation, the VSS scar score of Trial Group 1 (2.39 ± 0.82) and Trial Group 2 (2.44 ± 0.79) was significantly lower than the Control Group (6.86 ± 1.32). This proves that silk fibroin dressing and liquid dressing have a much better effect on preventing scars than conventional collagen dressing.

Why does silk fibroin have such a good effect? First, silk fibroin is a natural biological material. Its structure is very similar to the human skin matrix [6]. When it covers the wound, it can act as a strong biological scaffold. It can reduce the pulling force on the skin cells. Second, in modern biology, studies show that silk fibroin can reduce the expression of TGF-β1 factor. This factor is the main reason for bad collagen growth [7]. Also, silk fibroin can change the macrophages to reduce local inflammation. It helps the new collagen fibers grow in a neat line. So, the final scar is flat, soft, and has normal skin color [8].

At the same time, the liquid dressing also has a very good anti-scar effect. When the liquid is sprayed on the skin, it turns into a film quickly. This film acts like a physical splint. It sticks to the joint skin tightly and stops the skin from being pulled during joint movements. Moreover, this film can lock the water inside the skin. High water content in the skin will tell the fibroblasts to stop producing too much collagen. This is the main mechanism to prevent raised and red scars. But for the conventional collagen dressing, it only gives basic amino acids. It is too soft and cannot provide physical support. It also cannot keep the skin very wet during intense joint movement. So, the fibroblasts will grow too much because of the pulling force, leading to high VSS scores in the Control Group.

In terms of safety, the adverse reaction rates of the three groups were all very low (P > 0.05). The adverse reaction rate in the silk fibroin group was only 4.17%. This proves that silk fibroin is very safe and has no serious allergy. Because the scar looks good and there is no pain from pulling, the patient satisfaction rate in the silk fibroin group (93.75%) and liquid dressing group (95.83%) was significantly higher than the collagen group (75.00%).

In conclusion, for wound care after sports medicine surgeries, silk fibroin dressing and liquid

dressing are significantly better than conventional collagen dressing. They can ensure good wound healing, effectively prevent hypertrophic scars under moving tension, improve patient satisfaction, and have high safety. They are worthy of wide application and clinical promotion in the future.

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