JURNAL LOCUS: Penelitian & Pengabdian
Volume 5 No. 4 April 2026
E-ISSN 2829-7334| P-ISSN 2829-5439
Hompage: https://locus.rivierapublishing.id/index.php/jl

Effectiveness of *Secretome* on Accelerating Wound Epithelialization Resulting from Sports Injuries among Athletes at the University of Education (UPI) Bandung: A Pilot Experimental Study

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Keywords:
secretome, epithelialization, wound healing, athletes, pilot study

Abstract

Superficial wounds are common injuries among athletes due to repetitive and high-intensity physical activity. Epithelialization plays a crucial role in wound healing. *Secretome*, a stem-cell–derived biological product, contains growth factors, cytokines, and bioactive molecules that support tissue regeneration by promoting cell proliferation, modulating inflammation, and accelerating epithelial tissue formation. With the increasing relevance of regenerative medicine, topical *secretome* represents a promising intervention for enhancing wound healing. This pilot experimental study employed a quasi-experimental design involving athletes with superficial wounds. Eight participants were enrolled and allocated into two groups: an intervention group receiving topical *secretome* gel and a control group without *secretome* application. Wound healing was assessed by measuring changes in wound size, evaluating epithelialization progress, serial photographic documentation, and pain assessment using the Visual Analog Scale. Observations were performed throughout the designated follow-up period. Preliminary findings indicate that topical *secretome* application may accelerate epithelialization compared with the control group. Early improvements were observed through faster wound-size reduction, enhanced epithelialization quality, and decreased pain complaints. These initial results support the feasibility of the intervention and suggest potential therapeutic benefits of *secretome* for superficial wound healing in athletes. Topical *secretome* demonstrates potential in accelerating epithelialization in superficial wounds among athletes. As a pilot study, these findings provide foundational evidence for future large-scale research to further evaluate the effectiveness and safety of stemcell therapy. This study also highlights the potential role of regenerative medicine as an alternative approach to optimizing wound healing.

INTRODUCTION

Wounds represent a spectrum of skin injuries ranging from mild superficial abrasions to severe lacerations and penetrating trauma. As the largest organ of the human body, the skin serves as a critical protective barrier against external environmental factors. Disruption of skin integrity may arise from various causes, including accidents, athletic activities, surgical procedures, or underlying medical conditions. A comprehensive understanding of wound types is therefore essential to ensure appropriate management and to support effective tissue recovery (Powers et al., 2016; Sorg et al., 2017). Wound healing and treating wounds: chronic wound care and management. Beyond its mechanical barrier function, the skin plays a vital role in preventing microbial invasion, minimizing dehydration, and protecting

underlying structures from ultraviolet radiation, chemical and mechanical injury, and water loss.

The severity of wounds varies considerably, from superficial epithelial disruptions to deeper injuries involving blood vessels, muscles, and in some instances, bone. This variability necessitates differentiated therapeutic strategies, as wound depth and tissue involvement are major determinants of healing outcomes (Kolimi et al., 2022; Oliveira et al., 2022). The wound healing process itself is inherently complex, incorporating coordinated molecular and cellular events driven by growth factors, cytokines, and chemokines. These biological cascades regulate inflammation, cellular proliferation, regeneration, and tissue remodelling (Ahangar et al., 2020; Limanda et al., 2024; Vizoso et al., 2017; Xia et al., 2019). Despite advances in wound care, clinical outcomes are not always optimal, highlighting the need for novel therapeutic approaches that can enhance healing efficiency (González-González et al., 2020; Huang et al., 2023; Pokrovskaya et al., 2020).

In the field of sports medicine, tissue injuries are common due to repetitive and high-intensity physical activity, frequently affecting structures such as skin, ligaments, tendons, cartilage, muscle, and bone (Gwam et al., 2021; Yu et al., 2023). Stem cell–based therapies have emerged as a promising modality for managing such injuries through their potential to promote tissue repair, accelerate healing, and restore functional capacity (Mathieu et al., 2019). Prior clinical investigations have demonstrated encouraging results across various tissue types, including tendons, ligaments, meniscus, articular cartilage, epithelial tissue, and skeletal muscle. Within this therapeutic landscape, *secretome* defined as the collection of bioactive molecules released by stem cells has gained increasing attention due to its potential clinical benefits. However, current clinical application remains limited by formulation variability and an incomplete understanding of its biological activity (Bartaula-Brevik et al., 2017; Guo et al., 2022).

Previous studies have demonstrated the potential of *secretome* and stem cell–derived products in various clinical settings, including chronic wounds, degenerative diseases, and musculoskeletal injuries (Noverina et al., 2019; Zhao et al., 2021). However, most existing studies are limited to in vitro models, animal experiments, or chronic wound conditions, with relatively few investigations focusing on acute superficial wounds in athletes. Moreover, there is still limited clinical evidence regarding the topical application of *secretome* in real-world sports injury settings, particularly in terms of its effect on epithelialization speed and pain reduction. This indicates a clear research gap in translating regenerative medicine approaches into practical, field-based interventions for acute sports-related wounds (Zhao et al., 2021).

Existing research has explored the use of stem cell–derived products for a range of medical conditions, including sports-related injuries, cardiovascular disease, diabetes, and spinal cord injury. In sports medicine, *secretome*-based therapy has been identified as a promising alternative for enhancing cutaneous wound healing, with the potential to support timely tissue recovery and facilitate the return to athletic performance (Noverina et al., 2019). These considerations underscore the importance of preliminary investigations to evaluate the feasibility and therapeutic potential of *secretome* in managing superficial traumatic wounds among athletes.

Current literature highlights several limitations, including variability in *secretome* formulations, lack of standardized clinical protocols, and limited pilot-level human studies assessing feasibility and early therapeutic outcomes in specific populations such as athletes [8,16]. These gaps underscore the need for preliminary clinical research to bridge experimental findings with real-world application. Addressing this, the present study offers novelty by evaluating the topical use of *secretome* in acute superficial sports-related wounds, focusing on athletes in real-field settings, and providing pilot data on epithelialization rate,

pain reduction, and clinical feasibility. Furthermore, this study integrates clinical observation with quantitative wound assessment, contributing to the development of an evidence-based regenerative therapy approach in sports medicine.

The objectives of this study are to obtain therapeutic feasibility data on a stem cell-derived product in the wound-healing process among athletes, to determine the direct utility of *secretome* in promoting epithelialization of superficial traumatic sports-related wounds, and to generate preliminary data as well as estimate trends that may inform sample-size calculations for future studies. This study contributes to the development of applicable scientific knowledge regarding the effectiveness of *secretome* in the management of superficial athletic injuries. This pilot study aims to evaluate the practical feasibility of topical *secretome* application in the management of sports-related wounds among athletes at UPI.

METHOD

Study Design and Participants

This pilot quasi-experimental study was conducted among athletes presenting with superficial sports-related wounds within the UPI Bandung athletic setting. Participants were assigned to either a topical stem cell–derived *secretome* group or a control group without *secretome*. A total of eight eligible athletes were enrolled, with four participants per group.

Intervention and Procedures

The intervention group received topical *secretome* application, while the control group underwent standard wound care without *secretome*. Wounds were evaluated through repeated measures across scheduled follow-up visits. The primary aim was to assess the feasibility and preliminary therapeutic effect of *secretome* in accelerating epithelialization.

Outcome Measures

Wound healing was assessed by measuring changes in wound surface area, the progression of epithelialized tissue, serial photographic documentation, and pain intensity using the Visual Analog Scale (VAS). The independent variable was topical *secretome* application, and the dependent variable was epithelialization rate. Age, body mass index (BMI), athlete characteristics, and lesion measurement variability were considered potential confounders.

Sample Size Consideration

Although an initial sample size calculation yielded 18 participants based on a 95% confidence level and 80% power, the study was conducted as a preliminary pilot trial involving only eight participants who met the inclusion criteria. Each group consisted of four participants, and findings are intended to inform future sample-size estimations.

Wound Assessment

Wound area was quantified through serial surface tracing, and epithelialization was expressed as the percentage reduction from baseline. Wound assessment began by outlining wound margins and measuring wound surface area using tracing and the clock method on transparent metric film sheets graded in millimetres. The area of epithelialization was calculated at each visit. Each film sheet was single-use, and wound margins were marked with coloured markers (blue for visit 1, green for the next visit, and alternating thereafter). The percentage of epithelialized area was calculated based on the reduction in non-epithelialized surface compared with the initial measurement, using the following formula:

Notes:

Initial Wound Area (A_0) − Wound Area at Visit ($A_{1/2/3}$) × 100% ÷ Initial Wound Area

Epithelialization grading: grade 1 = 1–30%, 2 = 31–60% 3 = 61–90%, 4 = 91–100%

Evaluate also for pain scores (VAS 0–10) were recorded at each visit (A1,A2,A3). Wound healing progression was analyzed descriptively as preliminary feasibility data.

Ethical Clearance

There was *informed consent* for the patients. The papers describing experimental work on human participants which carries a risk of harm, must include (1) a statement that the experiments were conducted with the understanding and the consent of each participant, and (2) a statement that the responsible, ethical committee has approved the experiments. Clinical trials and behavioral evaluations with CONSORT Extension for Pilot & Feasibility Trials.

RESULTS AND DISCUSSION

The findings of this study are expected to provide preliminary insight into the potential of *secretome* as a safe and effective topical therapy for accelerating wound healing in athletes, and to serve as a foundation for the development of larger-scale research in the future. Early-stage investigations in other wound-healing therapies have likewise employed relatively small sample sizes, such as the pilot study by Mellado Sanz et al., which evaluated biophysical indicators of wound healing in eight patients with chronic wounds. In the present pilot study, eight eligible athlete participants were included, offering initial data that may inform subsequent, larger studies aimed at more comprehensively evaluating the effectiveness and safety of stem cell–based therapy as an alternative approach for managing superficial abrasions. These findings further support the advancement of topical therapeutic strategies designed to enhance epithelialization during the healing of superficial wounds.

Table 1. Comparison of Characteristics Between Groups

A. Age (years)

Group	n	Mean	SD	Range
Control (A)	4	22.5	2.1	20–25
Secretome (B)	4	23.0	1.8	21–25

B. BMI (kg/m²)

Group	Mean (SD)	Range	<19.8	19.8–25	>26
A	21.3 (1.2)	20–23	0	4	0
B	22.1 (1.5)	20–24	0	4	0

Source: Primary data from research, processed by researchers (2025)

The participants in this study were young adults with a mean age ranging from 22.5 to 23 years and were in good general health with no reported comorbidities. The athletes demonstrated an ideal body composition, with all participants in both groups falling within the normal Body Mass Index (BMI) range of 19.8–25 kg/m².

Table 2. Wound Epithelialization Rate

(change in mm²/day or epithelialization progress score)

Group	Mean	SD	Range
A (Control)	0.85	0.10	0.70–0.95
B (*Secretome*)	1.25	0.15	1.05–1.45

Source: Primary data from wound measurements, processed by researchers (2025)

Result shows that the *Secretome* group demonstrated a faster epithelialization rate, consistent with the expected biological effect.

Table 3. Incidence of Superficial Wound Complications

Complication	A (Control)	B (*Secretome*)
Wound infection (+)	0	0
Wound infection (–)	4	4

Source: Primary data from clinical observations, processed by researchers (2025)

Table 3 shows that no cases of superficial wound infection were observed in either group. All participants demonstrated uncomplicated wound progression throughout the observation period. No infection, consistent with moist wound healing principles associated with 0.9% NaCl care. Therefore, it exhibits a therapeutic effect equivalent to that of the stem cell preparation.

Table 4. Epithelialization Rate

Group	Mean (SD)	Range
A	0.85 (0.10)	0.70–0.95
B	1.25 (0.15)	1.05–1.45

Source: Primary data from wound measurements, processed by researchers (2025)

Table 5. Pain Score (VAS 0–10)

Group	Median	Range
A	4	3–6
B	2	1–3

Source: Primary data from respondent pain assessments, processed by researchers (2025)

Based on the above findings, the *secretome* group demonstrated: Faster epithelialization, Lower pain scores, and No wound infection. Indicating a more favorable healing profile compared with the control group. In contrast, the control group exhibited: slower epithelialization, higher pain intensity, and no wound infection, consistent with the principles of moist wound healing achieved with 0.9% NaCl care.This shows that while both groups showed absence of infection. Pain scores assessed using the Visual Analog Scale (VAS 0–10) showed a median of 2 (range 1–3) in the *secretome* group versus 4 (range 3–6) in the control group, indicating lower pain intensity among *secretome*-treated participants.

Sports Injury Distribution

Table 6. Distribution of Injury Cases by Sport Discipline Among UPI Athletes

Sport Discipline	Injury Region	Number of Injured Athletes
Athletics		
1) Short-distance running	Knee	1
2) Middle-distance running	–	0
3) Long-distance/relay running	–	0
Combat Sports		
Taekwondo / Pencak silat / Wrestling	0	0
Team and Racquet Sports		
1) Badminton	–	0
2) Volleyball	–	0
3) Softball	Knee and lower leg	1
4) Football	Elbow and knee	3
5) Futsal	Elbow	1

Total Participants: 8 athletes

Source: Primary data from observation and case recording, processed by researchers (2025)

Table 6 shows summarize the distribution of injuries across athletic disciplines within the UPI cohort. Of the eight participants, the majority were athletes in team sports three from futsal, one from football, and one from cricket while one was a short-distance runner. No participants were recruited from martial arts disciplines. Total sample consisted of eight injured athletes, mostly found wound on the knees and lower extremities.

Statistical Analysis

Mann–Whitney U testing demonstrated a statistically significant difference in epithelialization rate between the *secretome* and control groups ($p = 0.0286$). Pain scores also differed significantly between groups ($p = 0.0408$), with lower VAS scores observed in the *secretome* group. Fisher's Exact Test showed no significant difference in infection incidence between groups ($p = 1.00$). These results are summarized in the following table:

Table 7. Statistical Analysis Results

Variable	Comparison	Statistical Test	p-value	Interpretation
Epithelialization rate	Control vs *Secretome*	Mann–Whitney	0.0286	Significant
VAS pain score	Control vs *Secretome*	Mann–Whitney	0.0408	Significant
Wound infection	Control vs *Secretome*	Fisher's Exact	1.00	Not significant

Source: Primary data from statistical analysis (Mann–Whitney and Fisher's Exact Test), processed by researchers (2025)

Clinical Evaluation

Clinical monitoring digital photographic analysis can help demonstrated healing progression in the *secretome* group, with optimal epithelialization and absence of infection, hypertrophic scarring, or keloid formation. These observations support the feasibility and potential therapeutic benefit of *secretome* for superficial wound management in athletes.

Figure 1A and 1B displays an example of an acute sports-related wound in a 21-year-old male football athlete before treatment and on days 3 and 5 of wound care. Complete epithelialization was observed by day 5 following initial *secretome* application.

Several patients reported satisfaction with their wound-healing outcomes, demonstrating a markedly progressive epithelialization process, with substantial healing observed on days 3 and 5. Wound monitoring over less than one week indicated accelerated improvement in superficial abrasions, despite the fact that wounds located on the extremities (arms or legs) typically require 7–10 days to progress to the remodelling phase (Suhandi et al., 2023). The wound observation day 5, the healed wounds exhibited a normal (eutrophic) scar and did not require further treatment, as illustrated in Figure 1. Digital photographic analysis was employed to facilitate monitoring and to detect marginal surface erosion of the wound. Serial photographic documentation was conducted at each follow-up visit, accompanied by quantitative scale measurements in centimetres or millimetres on a wound map, serving as part of the clinical medical record. Final observational outcomes indicating 61–100% wound closure reflected successful healing or epithelialization based on the measured wound area, figure 1A.

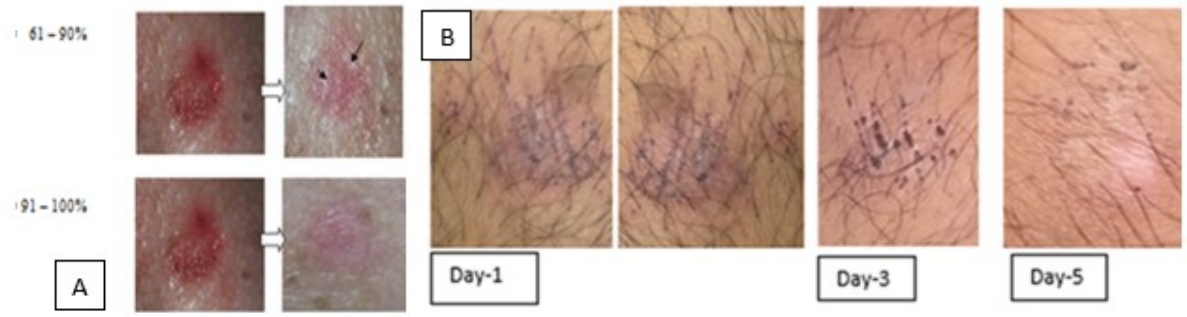

Figure 1. Clinical Development of Wound Healing Before and After *Secretome* Application (Day 0, Day 3, Day 5)
Source: Clinical documentation and photographic observations of research results, processed by researchers (2025).

In this study, topical application of 0.5–1 mL of *secretome* was administered uniformly across the superficial wound surface within the first 24 hours following the sports-related injury, as part of the standard wound care protocol. The wound was subsequently covered with a modern occlusive dressing (Opsite plaster) during daily athletic activities, with dressing changes performed once daily, except at night when the dressing was removed. Observation of the healing process revealed complete (100%) epithelialization by day 3 for elbow wounds and by day 5 for knee wounds, indicating optimal recovery of acute superficial wounds characterized by eutrophic scarring. These findings may serve as preliminary data to inform future studies involving advanced stem cell–based products or combination therapies, and may provide a basis for the development of cost-effective and clinically beneficial wound care innovations (Pokrovskaya et al., 2020)

The preliminary findings of this study support the feasibility of the intervention and indicate the potential effectiveness of *secretome* in promoting the healing of superficial wounds in athletes. Improvements in abrasion-type injuries among both team sport and athletic participants demonstrated optimal wound recovery, with no incidence case of wound infection or the development of hypertrophic scars or keloids. The result also shows that athletes mostly in game sports (soccer and futsal) more often experience injuries and shows traumatic wounds on the skin of the extremities, both on both arms and legs, followed by the incidence of injuries in athletes from athletics (short distance running). On the other hand eight athlete participants have achieved 100% re-epithelialization through wound map observations on day 5.

CONCLUSION

This pilot study demonstrates that topical *secretome* therapy is feasible and shows promising potential in accelerating epithelialization and reducing pain in superficial sports-related wounds among athletes. The *secretome*-treated group exhibited faster wound closure and favourable healing outcomes without infection or abnormal scarring, suggesting a beneficial therapeutic profile compared with standard saline-based care. Although limited by a small sample size, these preliminary findings provide early evidence to support further investigation in larger, controlled trials to more definitively evaluate the efficacy, safety, and clinical applicability of *secretome* as an adjunctive topical therapy for acute superficial wounds. However, this study is limited by a small sample size and short observation period, which restricts the generalizability of the findings. Therefore, further research is strongly recommended to involve larger sample sizes, randomized controlled designs, and longer follow-up durations to more comprehensively evaluate the effectiveness, safety, and long-term outcomes of *secretome* therapy. Future studies should also explore standardized

formulations, optimal dosage, and frequency of application to ensure consistency and reproducibility of results. In addition, integration with advanced wound assessment methods and comparison with other modern wound care modalities are suggested to strengthen clinical evidence. From a practical perspective, the implementation of *secretome* therapy in sports medicine should be accompanied by the development of standardized clinical protocols and guidelines. Overall, this study provides preliminary evidence that supports the potential role of *secretome* as an innovative regenerative approach in accelerating wound healing among athletes, while highlighting the need for further validation through more robust clinical investigations.

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