



Case Report: Recurrent Keloid Excision with Tension Reduction Suture and Adjuvant Closed Incision Negative Pressure Wound Therapy

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ABSTRACT

Background: Keloid management presents significant clinical challenges due to the very high recurrence rate after single surgical excision, reported to reach 50-100%. This failure is primarily caused by mechanical tension on the post-closure wound, which reactivates the fibroproliferative cascade. Closed Incision Negative Pressure Wound Therapy (ciNPWT) emerges as a promising adjuvant therapy because it directly targets this mechanical tension. This case report aims to present the effectiveness of a combination of excision, tension reduction sutures, and ciNPWT in high-risk recurrent keloids.

Methods: A 16-year-old male patient with a recurrent keloid on the right upper arm underwent a wide excision procedure and tension reduction suture technique. After wound closure, a ciNPWT dressing was applied over the incision line and connected

to a portable device. Continuous negative pressure therapy of -125 mmHg was maintained for 7 days post-operation.

Results: The surgical procedure and post-operative care proceeded smoothly without complications such as infection or wound dehiscence. After 7 days, the surgical wound appeared clean and tightly closed with minimal edema. At the 3-month follow-up, the scar appeared calm, flat, and aesthetic, with no clinical signs of keloid recurrence. The patient reported high satisfaction and resolution of itching complaints.

Discussion: The success of managing this case strongly validates the fundamental theory that mechanical tension is the primary trigger for keloid recurrence. The applied approach—through surgical excision followed by a tension reduction suture technique—directly targets this crucial factor. Furthermore, the application of ciNPWT as an adjuvant therapy functions as an effective external "mechanical splint." Its role is to neutralize residual tension on the wound and actively disrupt the profibrotic mechanotransduction cascade that triggers fibrosis. This mechanomodulatory strategy fundamentally addresses the root cause of keloid pathology, offering significant advantages over other adjuvant therapies that do not directly and specifically target the tension factor.

Conclusion: The combination of surgical excision, tension reduction suture technique, and adjuvant ciNPWT application proved to be a highly effective and rational management strategy for recurrent keloids. This multimodal approach successfully addresses the tension factor—identified as the primary etiology—thus precisely breaking the recurrence cycle. By fundamentally targeting its root cause, this strategy can be a superior therapeutic

option for cases with a high risk of recurrence.

Keywords: Keloid, Recurrence, Negative Pressure Wound Therapy, ciNPWT, Mechanotransduction, Upper Arm

INTRODUCTION

Keloids are a manifestation of fibroproliferative disorders arising from an abnormal and excessive wound healing process (De Brasi et al., 2020). Fundamentally, this pathology is based on an imbalance between the synthesis and degradation of the extracellular matrix, where keloid fibroblasts massively produce type I and III collagen (Datz et al., 2024; Chike-Obi et al., 2023). Clinically, keloids appear as scar tissue that grows beyond the original wound boundaries, often accompanied by itching and pain. Epidemiologically, keloids show a predilection for body areas with inherently high skin tension, such as the chest, shoulders, upper back, and upper arms (Son and Bae, 2020; Datz et al., 2024). Genetic and inflammatory factors also play a role, but modern scientific consensus places mechanical tension as the primary trigger and perpetuating factor in keloid pathogenesis (Ogawa, 2022; Wang et al., 2024).

The main clinical challenge in keloid management is their very high tendency to recur, especially after a single surgical intervention. Recurrence rates after simple excision are reported to reach 50% to 100%, which underlines that scar tissue removal alone is not enough (Guix et al., 2016). This phenomenon occurs because the excision itself creates a new wound that must be closed under tension, which in turn reactivates the profibrotic mechanotransduction cascade that initially caused the keloid (Ogawa, 2022; Datz et al., 2024). This failure creates a frustrating cycle of recurrence for patients and clinicians, where an excised keloid often grows back larger and more aggressive, as reflected in the case of An. AF (Case Report, 2025).

The failure of single excision confirms that adjuvant (additional) therapy is not merely an option, but a mandatory component in any rational, surgery-based keloid management strategy (Ejsperling et al., 2022). Various adjuvant modalities have been used with varying results. Intralesional corticosteroid injections are a common choice, but their recurrence rates are still high, ranging from 30-50%, and are accompanied by the risk of side effects such as skin atrophy and hypopigmentation (Son and Bae, 2020; Guix et al., 2016). Post-operative radiotherapy (PORT)

shows higher effectiveness with recurrence rates of only 6-27%, but its use is very limited, especially in young patients, due to significant concerns about the potential risk of long-term carcinogenicity (Guix et al., 2016). Non-invasive therapies such as silicone sheets are considered safe, but their effectiveness is limited for aggressive keloids and demands high patient compliance (Bleasdale et al., 2015). This gap creates an urgent need for an adjuvant therapy that can address the mechanical root cause of keloids with a good safety profile.

Closed Incision Negative Pressure Wound Therapy (ciNPWT) emerges as a promising adjuvant modality because it uniquely targets the mechanical triggers of keloids. Its primary mechanism of action is as an external "mechanical splint" that actively reduces lateral tension and shear forces on newly closed wounds through the application of negative pressure (Willy et al., 2016; Zwanenburg et al., 2022). By mitigating these tension signals, ciNPWT directly disrupts the initial step in the profibrotic mechanotransduction cascade. In addition, ciNPWT provides secondary benefits such as reducing edema, optimizing tissue perfusion, and improving lymphatic drainage, all of which create a microenvironment more conducive to physiological healing (O'Leary et al., 2017; Willy et al., 2016). Various systematic reviews and meta-analyses have proven that ciNPWT significantly reduces surgical wound complications and is associated with improved final scar quality (Cheatham et al., 2023; Singh et al., 2023).

Based on this background, this case report aims to present and analyze the clinical outcomes of recurrent keloid management in a high-risk patient using a combination of surgical excision and a tension reduction suture technique with the application of adjuvant ciNPWT. This report will detail the stages of the surgical procedure, post-operative management, and short- to medium-term monitoring results. Through the presentation of An. AF's case, this study is expected to provide clinical evidence regarding the effectiveness of ciNPWT as a mechanomodulatory strategy to break the cycle of keloid recurrence by directly targeting its main etiology: mechanical tension on the wound.

CASE REPORT

Patient Demographics

A 16-year-old male patient, An. AF, presented with a keloid on his right upper arm. The patient's anthropometric data were a weight of 71 kg and a height of 170 cm. The patient had a history of controlled asthma and no history of drug or food allergies. This keloid complaint was recurrent; it first appeared after a plate insertion surgery in 2021 and grew back larger after excision in 2022 (Figure 1).



Figure 1. Clinical Presentation of the Patient

Preoperative

Before the procedure, the patient and his guardian were given a complete explanation (informed consent) verbally and in writing regarding the diagnosis, the planned keloid excision and tension-reducing suture technique to be combined with ciNPWT application, the purpose of the therapy, potential benefits, risks of complications, and other alternative therapies. Clinical assessment and marking of the keloid area to be excised were performed. Pre-operative supporting

examinations, including routine laboratory tests, were conducted and showed results within normal limits. Consultation with an anesthesiologist was also carried out to ensure the patient's condition was suitable for surgery, especially given the history of asthma. To address the recurrence, the following three combinations were performed: total excision, tension-reducing sutures, and ciNPWT.

Anesthesia

The surgical procedure was performed in the operating room (OR). The procedure was carried out under general anesthesia to ensure patient comfort, airway control, and total immobilization during the procedure.

Surgical Procedure (Figure 2)

1. The patient was positioned supine on the operating table with the right arm abducted to facilitate access to the keloid area.
2. Asepsis and antisepsis were performed on the surgical field in the right brachial region.
3. A design for total excision was drawn using the zigzag incision / W-plasty method.
4. An incision was made according to the design. Total keloid excision was performed down to the depth of the deep muscle fascia.
5. Meticulous hemostasis was performed to minimize bleeding.
6. Fibrin sealant was sprayed (to prevent bleeding).
7. The wound was sutured in layers starting from the deep fascia, superficial fascia, subdermis, and skin surface using a tension-reducing suture technique.
8. After the wound was sutured, a sterile ciNPWT foam dressing was applied over the incision line. The dressing was ensured to be airtight, and the drainage tube was connected to a portable NPWT machine.
9. The ciNPWT device was activated with continuous negative pressure of -125 mmHg.





Figure 2. Stages of Surgery

Postoperative Management

Post-surgery, the patient was transferred to the recovery room for vital sign monitoring until stable. The function of the ciNPWT device was checked to ensure effective negative pressure was maintained. Post-operative pain management was provided as needed. The patient was educated on home care for the portable ciNPWT device, including how to identify alarms and warning signs such as increased pain, fever, or foul-smelling discharge from the dressing. The patient was also instructed to limit strenuous activities involving the right arm to optimize wound viability.

ciNPWT therapy was maintained for 7 days. After dressing removal, the wound was cared for conventionally, and the patient was scheduled for routine follow-up to monitor the healing process and evaluate for possible recurrence. The surgical procedure and postoperative care proceeded smoothly without complications such as infection, necrosis, wound dehiscence, or skin maceration. After 7 days, the ciNPWT dressing was removed, and the surgical wound appeared clean, dry, and well-approximated with minimal edema.

Further monitoring was carried out periodically. At the 12-day postoperative follow-up, the scar appeared calm, flat, and its color began to fade, approaching that of the surrounding skin (Figure 3). Most importantly, there were no clinical signs of keloid recurrence such as thickening, hardening, or growth beyond the wound boundaries. The patient was very satisfied with the aesthetic results achieved and no longer experienced the previous complaints of itching.



Figure 3. Before Surgery and 12 Days Post-Surgery

DISCUSSION

Keloid management is one of the greatest challenges in dermatology and plastic surgery, primarily due to its high tendency to recur after intervention. The case of An. AF, a 16-year-old male patient with a recurrent keloid on his right upper arm, is a perfect reflection of this clinical dilemma (Case Report, 2025). The patient's history shows a very common yet difficult-to-treat pattern: the keloid first appeared post-surgery in 2021, was then excised in 2022, only to grow back larger. This phenomenon underscores a crucial clinical principle: single surgical excision without adequate adjuvant therapy often not only fails but can also worsen the condition (Datz et al., 2023). The recurrence rate after simple excision is reported to be very high, ranging from 50% to almost 100%, which emphasizes that treatment strategies must extend beyond mere scar tissue removal (Guix et al., 2016; Ejsperling et al., 2022). This case, therefore, serves as an ideal prototype for exploring modern management strategies aimed at breaking this frustrating cycle of recurrence.

Pathophysiological Review: Fibroblast Dysregulation and Collagen Synthesis

To understand why keloids are so difficult to treat, it is important to review their unique pathophysiology. Keloids are fundamentally a fibroproliferative disorder resulting from a deviant and excessive wound healing process (De Brasi et al., 2020). At the core of this pathology is a severe imbalance between the synthesis and degradation of extracellular matrix (ECM) components. Keloid fibroblasts, the primary cells responsible for ECM production, exist in a hyperactive state, massively producing collagen—especially types I and III—as well as other growth factors (Datz et al., 2023; Chike-Obi et al., 2023). This process is exacerbated by a simultaneous decrease in ECM degradation activity. Inflammatory mediators, particularly Transforming Growth Factor–Beta (TGF- β), play a central role in driving this dysregulation, creating a persistently profibrotic environment (Son and Bae, 2020). Histologically, this manifests as an accumulation of thick, dense, and irregular collagen bundles known as "keloidal collagen," which is characteristic of these lesions (Datz et al., 2023; De Brasi et al., 2020).

Mechanical Tension as the Primary Trigger

Although genetic and inflammatory factors play important roles, modern scientific consensus places biomechanical forces, particularly skin tension, as the primary trigger and perpetuating factor in keloid pathogenesis (Ogawa, 2022; Wang et al., 2024). This is not merely an additional risk factor but a fundamental etiological element. Clinical observations consistently show that keloids occur more frequently in body areas with inherently high skin tension, such as the anterior chest, shoulders, upper back, and, as in the case of An. AF, the upper arm (Son and Bae, 2020; Datz et al., 2023). Further biomechanical studies reveal that the highest tension is found at the edges of growing keloid nodules, which mechanically explains why these lesions tend to spread laterally beyond the original wound boundaries, often forming crab-claw or dumbbell-like patterns (Wang et al., 2024). This understanding shifts the focus from merely treating existing lesions to modulating the mechanical environment of the wound itself.

Mechanotransduction: How Cells "Sense" Force

The process by which skin cells, especially fibroblasts, sense and respond to these mechanical forces is known as mechanotransduction (Sgandurra et al., 2018; Huang et al., 2021). This is a sophisticated molecular mechanism that converts physical signals into biological responses. The process can be explained through the "ECM-integrin-cytoskeleton-nucleus axis" (Sgandurra et al., 2018). When the skin is under tension, the surrounding ECM becomes stiff and stretches. This force is detected by transmembrane proteins called integrins, which are concentrated in focal adhesion complexes on the cell surface. Integrins then transmit this signal into the cell via the actin cytoskeleton, a type of internal cellular framework. Tension on this cytoskeleton acts as a second messenger, ultimately affecting proteins that can translocate into the nucleus and alter gene expression programs (Sgandurra et al., 2018; Li et al., 2022). In other words, the cell literally "feels" the pull and changes its behavior in response.

From Mechanical Force to Profibrotic Response

This mechanotransduction cascade is what directly links mechanical tension to the

uncontrolled profibrotic response in keloids. Tension transmitted through the cytoskeleton triggers a series of intracellular events, one of the most critical being the activation and release of the primary profibrotic mediator, TGF- β 1 (Huang et al., 2021). Active TGF- β 1 then binds to its own receptors on the fibroblast surface, initiating a positive feedback (feed-forward) loop. The stimulated fibroblast produces more TGF- β 1, more α -smooth muscle actin (α -SMA) which increases cell contractility, and, most importantly, more collagen. This massive collagen production makes the ECM stiffer and denser, which in turn increases tension on the surrounding cells, thus perpetuating this pathological cycle (Huang et al., 2021; Son and Bae, 2020). This understanding is crucial because it explains why sustained tension on a wound can lead to the progressive and uncontrolled fibrosis characteristic of keloids.

Limitations of Single Excision and the Importance of Adjuvant Therapy

Based on the understanding of the central role of mechanical tension, it becomes clear why single surgical excision almost always fails for true keloids. The act of excision, while removing existing scar tissue, inherently creates a new wound that must be closed under tension (Ogawa, 2022; Datz et al., 2023). This closure tension, especially in high-risk areas, effectively "reignites" the same mechanotransduction cascade that caused the keloid in the first place. Therefore, without additional intervention to counteract this tension, recurrence is almost inevitable (Guix et al., 2016). This leads to an undeniable clinical conclusion: adjuvant therapy is not an option but a mandatory component of any rational, excision-based keloid management strategy (Ejsperling et al., 2022). Its goal is to break the cycle of recurrence by targeting the underlying pathophysiological mechanisms immediately after excision.

Tension Reduction Suturing as Delivered by Rei Ogawa

To address this challenge, suturing techniques specifically designed to reduce dermal tension become a critically important component. Subcutaneous/fascial tension reduction suture techniques, as pioneered and extensively described by Rei Ogawa, offer an elegant and biomechanically effective solution (Ogawa et al., 2011). This technique differs fundamentally from

conventional layered closure by transferring the tension load from the vulnerable dermis to stronger, more stable deep connective tissue structures.

Anatomical Rationale: Protecting the Dermis

The basis of this technique lies in understanding the functional anatomy of the body wall layers. The dermis is the site of origin for keloid fibroblasts and must be a "tension-free" zone. Beneath it lies the superficial fascia, a fibrous network within the subcutaneous fat, and deeper still is the deep fascia, a strong and relatively inelastic layer of dense connective tissue that covers the muscles (Ogawa, 2020). The deep fascia, due to its superior structural integrity, serves as an ideal anchor point for tension-bearing sutures. By transferring almost the entire wound closure load to this layer, the overlying dermis is effectively "protected" from the mechanical forces that would trigger keloidogenesis (Ogawa et al., 2011).

Step-by-Step Surgical Technique

Proper implementation of the Ogawa method is essential for its success and involves the following steps, adapted from descriptions in the literature (Ogawa et al., 2011; Ogawa, 2020) (Figure 4):

1. **Wide Excision:** The keloid tissue is removed entirely down to the level of the deep fascia, ensuring no residual fibrotic tissue remains.
2. **Sub-fascial Undermining:** This is the most crucial and distinguishing step. The dissection plane is developed *under* the deep fascia, between the fascia and the underlying muscle. This step mobilizes the entire soft tissue unit (skin, fat, and fascia) as a single entity. This is fundamentally different from conventional subcutaneous undermining, which only mobilizes the skin and fat above a fixed fascia, thereby still stretching the dermis during closure. Sub-fascial undermining allows the entire unit to be advanced without creating tension on the dermis.
3. **Deep Fascia Suturing:** Strong, long-lasting sutures, such as size 0 or 2-0 Polydioxanone (PDS), are placed to approximate the edges of the deep fascia. This single layer

biomechanically bears approximately 90% of the total closure tension (Ogawa, 2020).

4. **Superficial Fascia Suturing:** Size 2-0 or 3-0 PDS sutures are then placed in the superficial fascia. This layer manages the remaining 10% of tension and helps in the approximation of subcutaneous tissue, eliminating dead space (Ogawa, 2020).
5. **Dermis and Subdermis Suturing:** After the fascial suturing is complete, the dermal and epidermal edges should coapt naturally with little to no tension. If required, dermal sutures (e.g., 4-0 PDS) serve only for edge approximation, not for bearing tension. This is a key difference from conventional layered closure, where dermal sutures often serve as the primary tension-bearing layer.
6. **Skin Surface Suturing:** Interrupted skin sutures using 4-0 or 5-0 Nylon are performed to help approximate the wound edges more closely.

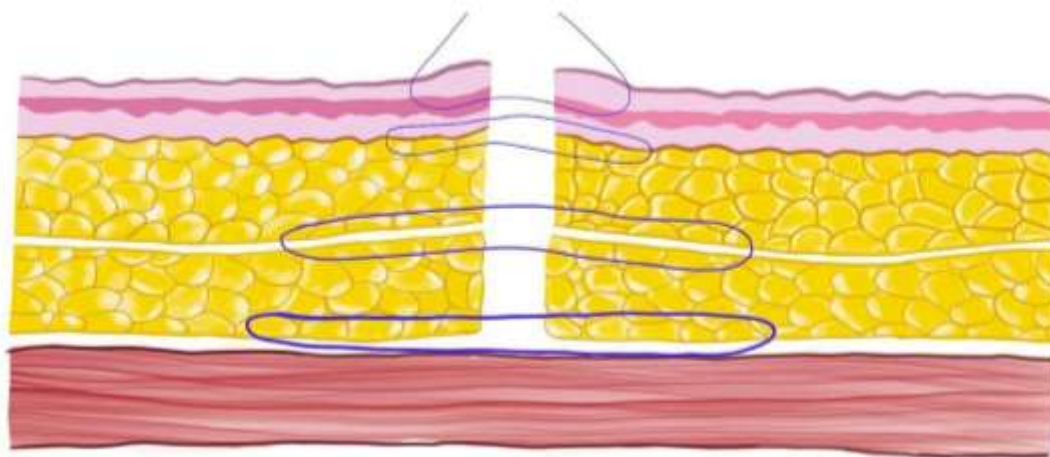


Figure 4. Tension Reduction Suturing

Comparative Review of Conventional Adjuvant Therapies (Table 1)

Various adjuvant therapies have been used with varying degrees of success. Intralesional corticosteroid injections, such as triamcinolone, work by suppressing inflammation and fibroblast

activity, but recurrence rates after excision remain high, reported between 30-50% (Son and Bae, 2020; Guix et al., 2016). Post-operative radiotherapy (PORT) is far more effective, with recurrence rates as low as 6-27%, owing to its ability to induce apoptosis in rapidly proliferating fibroblasts. However, its use is limited by significant concerns regarding the potential risk of long-term carcinogenicity, especially in young patients (Guix et al., 2016). The most common non-invasive therapy is silicone gel sheeting, which is considered a first-line therapy for prevention and treatment. Its mechanism is believed to be related to increased hydration of the stratum corneum through occlusion, which normalizes the skin's microenvironment and calms fibroblast activity (BAPSCARCARE, 2023; Bleasdale et al., 2015). Each of these modalities has advantages and disadvantages, creating a need for an alternative therapy that can address the mechanical root cause of keloids with a favorable safety profile.

Table 1. Comparative Analysis of Adjuvant Therapies for Keloid Recurrence Prevention

Therapy	Primary Mechanism of Action	Recurrence Rate (Post-Excision)	General Protocol	Advantages / Disadvantages
ciNPWT	Mechanical Splinting & Tension Release	Limited direct data; strong evidence for complication reduction & scar improvement (Cheatham et al., 2023)	Continuous negative pressure of -125 mmHg for 7 days post-operation	Advantages: Addresses root cause (tension), non-invasive post-application. Disadvantages: Cost, potential for skin blisters, requires a device.

Therapy	Primary Mechanism of Action	Recurrence Rate (Post-Excision)	General Protocol	Advantages / Disadvantages
Intralesional Corticosteroids	Anti-inflammatory & Fibroblast Suppression	30–50% (Guix et al., 2016)	Injections at wound closure and repeated periodically	Advantages: Widely available, low cost. Disadvantages: Painful injections, risk of skin atrophy, hypopigmentation, high recurrence rate.
Radiotherapy (PORT)	Fibroblast Apoptosis & Anti-angiogenesis	6–27% (Guix et al., 2016)	Administered immediately post-operation in fractionated doses	Advantages: Highly effective. Disadvantages: Risk of long-term carcinogenicity, requires specialized facilities, can cause

Therapy	Primary Mechanism of Action	Recurrence Rate (Post-Excision)	General Protocol	Advantages / Disadvantages
				hyperpigmentation.
Silicone Sheeting	Occlusion & Stratum Corneum Hydration	Varies; used for prevention	Applied after full re-epithelialization, used for months	Advantages: Safe, non-invasive, easy to use. Disadvantages: Patient compliance issues, limited effectiveness for aggressive keloids, can cause skin irritation.

ciNPWT as a Mechanomodulatory Tool

Primary Mechanism of Action of ciNPWT: Anti-Tension Effect

Closed Incision Negative Pressure Wound Therapy (ciNPWT) emerges as a promising adjuvant modality because it uniquely targets the mechanical triggers of keloids. Its primary mechanism of action is its function as an external "mechanical splint." When an occlusive dressing

is applied over a closed incision and connected to a vacuum source, the generated negative pressure actively pulls the wound edges together. This action significantly reduces the lateral tension and shear stress experienced by the newly formed scar tissue (Willy et al., 2016; Zwanenburg et al., 2022). By effectively "turning off" these excessive tension signals, ciNPWT directly disrupts the first step in the profibrotic mechanotransduction cascade. This is a mechanomodulatory approach that is fundamentally different from the biochemical or cytotoxic approaches of other adjuvant therapies.

Secondary Benefits: Edema Reduction and Microenvironment Optimization

In addition to its primary mechanical effect, ciNPWT provides several important secondary benefits that optimize the wound healing environment. The sub-atmospheric negative pressure creates a pressure gradient that facilitates the removal of edema fluid and inflammatory exudates from the interstitial space around the incision (O'Leary et al., 2017; Al-Subaie et al., 2024). This reduction in edema not only decreases local hydrostatic pressure, which can further alleviate tissue tension, but also creates a microenvironment less conducive to prolonged inflammation and bacterial proliferation (Pellino et al., 2022). By keeping the wound dry and less swollen, ciNPWT helps guide the healing process toward a more physiological and less fibrotic pathway.

Impact on Tissue Perfusion and Lymphatic Drainage

The effect of ciNPWT on microcirculation around the wound also contributes to better outcomes. A number of studies have shown that the application of ciNPWT can increase blood flow and tissue perfusion in the skin adjacent to the incision (Willy et al., 2016; Nam et al., 2016). The mechanism is complex and may involve the formation of a mild hypoperfusion zone directly at the wound edge combined with a compensatory hyperperfusion zone in the surrounding area, a pattern believed to stimulate angiogenesis (new blood vessel formation) (Malmsjö et al., 2014). This increased perfusion ensures better delivery of oxygen and nutrients to the healing cells. Additionally, ciNPWT has been shown to improve lymphatic clearance, which efficiently removes hematoma and seroma precursors from the wound, both of which are complications that can

increase local tension and inflammation (Willy et al., 2016).

Application Parameters: Importance of Pressure and Duration

The success of ciNPWT therapy is highly dependent on adherence to proven application protocols. In the case report of An. AF, the application of continuous negative pressure at -125 mmHg for a full 7 days was key to its success (Case Report, 2025). The -125 mmHg pressure setting is the most widely studied and has been consistently proven effective in reducing post-operative complications in various studies (Singh et al., 2023; Cheatham et al., 2023; Al-Subaie et al., 2024). The 7-day duration is also crucial, as this covers the initial inflammatory and proliferative phases of wound healing—the period when the wound is most vulnerable to detrimental mechanical stimuli. Uninterrupted application during this critical period ensures that the wound remains stable and protected from tension as the foundation for mature scar tissue is being laid.

Evidence from Systematic Reviews and Meta-analyses

The clinical benefits of ciNPWT are supported by a growing body of scientific evidence. A number of large-scale systematic reviews and meta-analyses consistently demonstrate that the use of ciNPWT on closed surgical incisions significantly reduces the incidence of surgical site complications (SSCs) compared to standard dressings (Willy et al., 2016; Cheatham et al., 2023; Sandy-Hodgetts et al., 2015). Complications that are proven to be reduced include surgical site infection (SSI), seroma formation, and wound dehiscence (wound reopening). For example, a comprehensive meta-analysis involving dozens of studies found that ciNPWT reduced the overall risk of SSI by approximately 47% (Cheatham et al., 2023). This high-level evidence provides a strong foundation for the use of ciNPWT in preventing poor wound outcomes.

Specific Evidence on Improved Scar Quality

Most relevant to keloid prevention is the evidence suggesting that ciNPWT may also improve the aesthetic quality of the final scar. Several meta-analyses explicitly report that the use of

ciNPWT is associated with statistically better scar outcomes at various post-operative time points (Cheatham et al., 2023; Singh et al., 2023). A computational thesis also concluded that ciNPWT can minimize scar formation (Zwanenburg, 2019). Although some studies note that this benefit may be more apparent in patient-reported outcome measures (PROMs) than in objective quantitative measurements such as scar width (Zwanenburg et al., 2022), the overall trend is consistently positive. These findings serve as an important conceptual bridge, linking the ability of ciNPWT to prevent common complications with its potential to specifically prevent the formation of pathological scars like keloids.

Analyzing the Success of An. AF's Case

When the evidence from the literature is applied to the case report of An. AF, the observed clinical success becomes highly understandable. The excellent results at the 3-month post-operative follow-up—a calm, flat, non-raised scar, and most importantly, no signs of keloid recurrence—are fully aligned with the findings from meta-analyses reporting improved scar quality (Case Report, 2025; Cheatham et al., 2023). The success in this case can be directly attributed to the application of an appropriate mechanomodulatory strategy. By using ciNPWT, the primary risk factor for recurrence—namely, mechanical tension on the incision—was effectively mitigated in a patient at very high risk (with a history of aggressive recurrence, young age, and an anatomical location in a high-tension area). Thus, the case of An. AF serves as a strong *in-vivo* clinical validation of the scientific principles underlying ciNPWT.

The Role of ciNPWT in Reducing Economic and Patient Burden

The benefits of ciNPWT extend beyond complication prevention and aesthetic outcomes. By reducing the rates of SSI, dehiscence, and seroma, the therapy has also been shown to significantly reduce readmission rates, the need for reoperation, and overall hospital length of stay (Cheatham et al., 2023; Singh et al., 2023). The economic implications of this are substantial. Furthermore, data indicate that patients treated with ciNPWT report lower post-operative pain scores and require fewer opioid analgesics (Cheatham et al., 2023). These benefits, combined with higher patient

satisfaction with cosmetic results and the resolution of bothersome symptoms like itching (as reported by An. AF), collectively improve the patient's quality of life significantly while reducing the cost burden on the healthcare system (Case Report, 2025).

Post-Operative Care Protocol and Patient Education

To maximize the effectiveness of ciNPWT, careful and structured post-operative management is essential, as well-illustrated in the case report of An. AF (Case Report, 2025). This begins in the recovery room by ensuring the device is functioning correctly and that negative pressure is effectively applied. Adequate pain management must be provided. However, the most critical component is patient and family education. Before discharge, the patient and their guardian must receive clear and comprehensive instructions on how to care for the portable device, how to identify alarm sounds and their meanings, and danger signs that require immediate medical attention (e.g., fever, worsening pain, or foul-smelling discharge from the dressing). Additionally, instructions to limit strenuous physical activity involving the operated area—in this case, the right arm—are vital to minimize mechanical disruption to the healing wound.

A Balanced Review of Potential Complications

Although ciNPWT is generally considered safe and no complications were reported in the case of An. AF, it is important for clinicians to present a balanced review of its potential side effects (Case Report, 2025). Systematic reviews and clinical trials have identified several risks. The most frequently reported and statistically significant complication is an increased incidence of skin blistering around the edges of the adhesive dressing (Norman et al., 2022). Other local skin reactions, such as maceration or contact dermatitis, may also occur, though less frequently. It is important for the surgical team to be aware of these risks and take steps to mitigate them, such as careful dressing application without stretching the surrounding skin, the use of skin protectants, and routine monitoring of skin integrity around the dressing. The absence of complications in the case of An. AF suggests that with proper technique and careful monitoring, these risks can be effectively managed.

CONCLUSION

The management of recurrent keloids presents a significant clinical challenge, primarily due to the very high rate of recurrence following single surgical excision. This failure is rooted in the fact that mechanical tension on the post-closure wound reactivates the very pathological pathway that caused the keloid to form in the first place. The case report of patient An. AF, an adolescent with a history of a keloid that grew back more aggressively after a previous excision in a high-tension area, serves as a clear example of this frustrating cycle of recurrence and highlights the limitations of conventional approaches. This case confirms that a successful treatment strategy must go beyond mere scar tissue removal and actively target the underlying biomechanical triggers.

The intervention applied in this case—a combination of surgical excision followed by a meticulous tension reduction suture technique with the application of adjuvant Closed Incision Negative Pressure Wound Therapy (ciNPWT)—was aimed directly at addressing the root pathophysiological cause of keloids. The use of ciNPWT for seven days post-operation functions as an external "mechanical splint." By providing continuous negative pressure, the device effectively neutralizes lateral tension on the incision line, thereby directly disrupting the profibrotic mechanotransduction cascade that is crucial for keloid growth. This mechanomodulatory approach, coupled with the secondary benefits of ciNPWT in reducing edema and optimizing the healing environment, forms the rational basis for preventing recurrence.

The implementation of this strategy in the case of An. AF demonstrated outstanding clinical success and proceeded smoothly without complications. At the three-month post-operative follow-up, the achieved result was highly satisfactory: the wound healed well, resulting in a calm, flat, and aesthetically mature scar. Most importantly, there were no clinical signs of keloid recurrence, whether in the form of thickening, hardening, or tissue growth beyond the wound boundaries. This success was not only reflected in the objective assessment by the clinician but also in the high patient satisfaction and the resolution of subjective complaints such as the previously very bothersome itching.

Thus, this case report provides strong clinical evidence that the combination of surgical excision, tension reduction sutures, and adjuvant ciNPWT constitutes a highly effective and rational strategy for the management of recurrent keloids, especially in high-risk patients and anatomical locations. By directly targeting and mitigating mechanical tension, this approach is able to break the pathological cycle that drives recurrence. Therefore, this mechanomodulatory strategy can be considered a superior therapeutic option that holds great promise for significantly improving clinical outcomes, quality of life, and patient satisfaction in dealing with one of the most challenging conditions in this field.

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