Heel Reconstruction with Sensate Medial Plantar Flap

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Abstract

Background: The heal had distinctive anatomical feature that serve as weight bearing structure and any defect in heal result in gait instability and therefore the tissue used to reconstruct the heel area must be resistant, innervated, and adapted to adjust to the body weight. The aim of study is to evaluate the outcomes of heel reconstruction using the Sensate medial plantar flap in group of patients, emphasizing its efficacy in restoring function and sensation.

Patients and Methods: The study is prospective-descriptive case series conducted from 2020-2024, in four hospitals, patients who presented with heel soft tissue defects of various etiologies. SMPF is used in reconstructive

Results: The study involved 26 patients, majority of them being male (92.3%) and the remaining (7.7%) were female, with participants' mean age was (35.42) years, most of patients present with size defect >3cm in (76.9%) , with non-neurotrophic ulcer in (73.1%) , preoperative doppler US is used in (69.2%) . The overall survival rate of flap (96.15%) and with complication rate (19.15%),

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(11.5%) necessitate reoperation , these uneventfully complications like total flap loss (3.8%) which reoperated and , partial flap necrosis (3.8%) . Donor site covered with split thickness skin graft, with complications such as graft loss / dehiscence which healed with secondary intention (7.7%), (3.8%)total graft loss require reoperation .

Conclusions: the use of SMPF for reconstructing heel defect is highly adaptable technique and is widely regarded as one of the best options for repairing soft tissue defect of heel. This is due to its sensivtiy and ability to replace the damaged area with similar structure following the idea of "like with like ''

Key Words: heel defect, heel reconstruction, sensate medial plantar flap, sensation .

Introduction:

The heel is a crucial part of the foot, containing specialized connective tissue with a thick dermis and epidermis, perpendicular fibrous septa, and adipose tissue compartments. It absorbs most of the body's weight when walking or standing and can bear up to 260% of a runner's weight. Trauma is the leading cause of heel soft tissue anomalies, and other factors contributing to metabolic syndrome include vascular disease, infections, and cancer surgery-related problems. Reconstructive surgeons face significant challenges in treating burns due to the distinct differences in dermal characteristics between the heel and sole. The plantar region of the foot, particularly the heel, has a unique intrinsic characteristic that allows it to adapt to substantial pressure and sliding forces experienced during standing and walking. The heel has thicker skin, enabling it to endure greater pressure and strain compared to the rest of the foot. The construction of a functionally repaired plantar foot architecture after surgery is of utmost importance and presents significant challenges.

The optimal strategy for correcting heel abnormalities is to regenerate tissue that closely resembles the original tissue. An ideal choice for reconstruction would be durable and gentle on the senses, while minimizing the likelihood of problems. Techniques for correcting defects in the heel include skin grafts, regional flaps, cross-leg flaps, local random flaps, and free tissue transfer. However, skin grafts do not provide sustained assistance for the weight-bearing region of the heel.Researchers have proposed various methodologies to address heel deformities, but none have demonstrated satisfactory structural or functional outcomes. The medial plantar flap is a highly effective method for correcting calcaneal abnormalities, particularly on the skin of the sole of the foot, particularly at the level of the heel bone. This method minimizes harm to the surrounding area while providing pressure-resistant, structurally and texturally uniform skin. In Yemen, heel abnormalities resulting from burns, neuropathic ulcers, and motorcycling accidents are prevalent. Plastic surgeons in

Yemen are attempting to solve this problem by removing dead tissue with partial or full-thickness skin grafts. However, many patients have encountered calcaneus osteomyelitis and ulcers over time, leading to the investigation into alternative solutions.

A reverse sural flap has been considered a viable surgical approach for addressing the deficiency of soft tissue in the heel. However, patients have experienced discomfort and discontent due to the frail and burdensome tissue, causing a recurrence of heel ulcers. We employed a method that involved administering methylene blue in close proximity to the nerve region to resolve this issue, demonstrating exceptional coverage, resilience, and efficacy in addressing soft tissue deficiency in the heel.

Material and methods:

A team of plastic surgeons conducted the study in four hospitals: the police hospital, Al Elite hospital, military hospital, and Algamhori hospital. The study enrolled 26 patients who underwent sensate medial planter flap repair for defects in the heel's soft tissue. Data collection involved gathering demographic information about the patients, such as age, gender, smoking habits, use of a tourniquet, and loupe magnification. The researchers also documented the precise characteristics of the defect, including its measurements, location, and any associated damage. We revised the exclusion criteria to include individuals with immunosuppression, vasculopathy, coagulopathy, and malnutrition. We analyzed the data using SPSS version 26, applying descriptive statistics to delineate patient characteristics, surgical procedure specifics, and post-surgery outcomes. We compared success rates among different groups using Chi-Square and Fisher's exact tests, and conducted univariate analysis to identify factors contributing to the flap's success. We evaluated secondary outcomes by determining complication rates and comparing them between groups using Chi-Square and Mann-Whitney U tests. The study's primary goal was to evaluate the efficacy of the flaps used. We determined the success rate by measuring the

amount of blood flowing forward in the posterior tibial artery, determining the fraction of flaps that completely survived, and assessing the influence of additional variables such as defect size, viability of the skin graft from the donor site, underlying cause of the condition, operation duration, specific habits, and patient characteristics. Secondary outcome measures, including the frequency of recurring ulceration, partial or complete flap loss, delayed wound healing, and sensory hyposensitivity in the forefoot and hindfoot, evaluated the complication rate. During the post-treatment protocol, we periodically monitored the patients, conducting examinations every three days and monthly visits for six months until complete recuperation. The average follow-up period was 12 months, involving assessing the wound, changing bandages, and removing stitches. The sensate medial plantar flap was marked, and the flap design, which depends on an axis extending from the base of the first metatarsal distally to the sustentaculum tali with avoidance, incorporates weight-bearing skin areas of the foot into the flap and is then harvested to cover the defects. The procedure was done under general anesthesia, tourniquet control, and loop magnification. A plantar incision is made, and the dissection is performed in a subfascial plane. above the abductor hallucis muscle in a dorsal direction until the pedicle of the flap is visualized. See figure (1,2)

Figure 1 :Flap marking

Figure 2: skin incision and harvesting

Started flap elevation from distal to proximal in a plain-tell appearance of abductor hallucis and planter facia included MPA is explored in the septum between abductor hallucis and extensor digitorum brevis, where it was divided and elevated within the flap. See figure (3)


Fig 3 . elevation of the flap

Neurovascular bundle is obtained and MPN is identified in which splinting cutaneous part of the nerve is included within flaps made it sensitive, and obligatory continuous dissection proximally until a sufficient arc of rotation of the flap is made cover to the flap inset. See figure (4,5)

Fig .4 : neurovascular bundle

Fig.5: rotation of flap

The donor site was covered by split thickness skin graft. A tie-over closure dressing was used to further secure the skin graft. See Figure (5)

Figure 5: split thickness for flap donor site

In some patients where the heel defect less or equal to 3 cm flap elevation, then advance posteriorly, without division of MPA or splinting MPN as keystone flap see figure (6)

Figure 6: keystone flap

postoperative a comprehensive follow-up protocol applied to monitor healing progress regularly, mainly the first 48 hours to monitor the flap survival each 4 hours through observation, the color and hotness of the flap average follow-up time of 12 months.

Statistical analysis:

We analyzed the data using SPSS version 26. We used descriptive statistics to summarize the patient demographics, intraoperative details, and postoperative outcomes .For outcomes, a p-value less than 0.05 was considered statistically significant.

Results:

Analysis of 26 patients with heel defects who underwent SMPF showed that there were 24 males and 2 females, with a male-to-female ratio of 12:1. The average age of the average age of the participants was 35.42 years, with a range from 1 to 60 years. The most common cause of a healing defect is acute trauma. 69.25% (N = 18), followed by neurological disease 26.9% (N = 7), burn 3.8% (N = 1), and about 73.1% (N = 19), of which they had non-neurotrophic ulcers and the rest had neurotrophic ulcers. 26.9% (N=7) Most of them present with defects larger than 3 cm. 76.9% (N = 20) need split-thickened skin grafting for the flap donor site and less than 3 cm 23.1% (N = 6) patients covered their defect with MPAP keystone flaps, 19.2% (N = 5). They were smokers with little impact on survival since they were instructed to stop smoking at least 2 weeks before the operation, and most of the patients are nonsmokers. 80.8% (N = 21),, Preoperative diagnostic imaging of the arterial system of the lower extremities was performed by Doppler ultrasound or angiogram since these are mandatory. Done in 69.2% (N = 18), additional investigation of the CT angiography is done in high-risk patients. 23.1% (N=6). with a high flap survival rate of about 96.25, and only 5 cases had complications; the most common issue for donors is graft loss with dehiscence (7.7%). One case was observed to heal with secondary intention; another case was reoperated (3.8%), with smaller percentages experiencing complete flap loss requiring reoperation (3.8%); or the other case had partial flap loss that was not operated on (3.8%). No venous congestion, flap infection, or seroma.

Discussion:

While attempting to replace damaged soft tissue in the heel with long-lasting tissue, surgeons have faced challenges. The skin's unusual structure at this level is the main reason for this. Over time, it has developed the capacity to bear the weight and force exerted by the entire body, as well as the strain of daily tasks (3). Moreover, when standing, the heel bears almost 80% of the body weight, offering shock absorption at this magnitude. The vertical fibrous septa, located between the fascia and dermis, divide the subcutaneous fat into several regions. These septa may function as "shock absorbers." Moreover, it is crucial to acknowledge that utilizing this flap offers substantial advantages. The flap produces both practical and visual outcomes, and its nerve supply enhances its defensive sensitivity. Numerous research organizations have thoroughly examined flaps, demonstrating their efficacy and long-lasting nature. In 2004, Benito-Ruiz et al.(5) conducted a study on six medial plantar flaps, resulting in a survival rate of 83%. Only five cases showed total necrosis. Additionally In 2022, Vijay Kumar and his colleagues reported doing 22 MPF flaps.(6) .He encountered two instances of partial graft loss. each with a 9% loss rate. Additionally, one occurrence resulted in the loss of the entire graft, with a loss rate of 4.5%. One instance resulted in total flap loss, while two instances resulted in partial flap loss. The survival rate was 95.5%, while the complication rate was 31.5% (6). In our study, of the 26 patients who received ipsilateral SMPF for reconstruction, the youngest had the highest level of activity. Many studies have a common age range. We find that trauma accounts for 69.25% of heel malformations, which is the same outcome as the Maourougan study (2006), which also identified trauma as the primary source of defects. In our study of 26 patients, we performed reoperations on one instance of complete flap loss and another instance of partial flap necrosis. The majority of the flaps, specifically 92.4%, were intact. In addition, the 2010 Ma Kalam study used d the sural reverse flap technique to address the loss of one medial plantar flap (7).

Furthermore, N. Senthilkumar's 2024 work demonstrates that MPF can effectively restore a heel deformity resulting from acral melanoma and SCC. These findings align with our own results and provide additional support for our conclusions. Furthermore, Sanjay's work corroborates our findings by further exploring the benefits of including post-electric and post-debridement procedures and their impact on outcomes. (8) In two cases, complications such as graft loss or dehiscence occurred at the donor site, with one case leading to complete graft loss. In the year 2018, Michaela Pertal et al.'s investigation of five patients demonstrates improved outcomes in individuals with SMPF since there were no instances of rapid necrosis or ulceration observed (9). Deepak Krishna et al. analyzed 8 instances and found that 2 out of 8 cases, or 25%, reported the desired outcome. Eight patients who underwent medial plantar flap surgery for a neurotrophic heel defect developed delayed necrosis. However, they also achieved sensory improvement during a period of 5-8 months. In 2023, the Sunkit Study found that 10% of the cases had flap necrosis and 20% had suture site dehiscence. These complications were primarily ascribed to the presence of comorbidities in the patients, which is in contrast to our previous research, where trauma was the most common cause. (10) In our investigation, we found that sensibility is well-preserved across the flap in all 16 patients, with no specific areas showing a loss of sensitivity. However, the remaining 11 patients reported experiencing either hypoesthesia (reduced sensation) or hyperesthesia (increased sensation). Without any subsequent action or response. Since The medial plantar fascicles are part of the cutaneous nerve. The nerve does not permanently impair tactile feeling. .Nevertheless, the nerve might cause a temporary impairment in the sensation of the toes. Reduced as a result of neurapraxia. Eleven. All sensory flaps Following surgery, thorough postoperative monitoring resulted in the recovery of both the ability to feel and the ability to protect oneself, but the time it took for this to happen varied. Derrick G. Wan et al. (12) demonstrated that a flexible medial plantar flap can

provide immediate sensation, effectively address heel abnormalities, and minimize damage to the donor site. A comprehensive neurological examination has shown that it is possible to preserve normal sensation by delicately dissecting the flap while protecting its sensory organs. Across the entire flap. Trevatt et al.'s findings, incorporating two-point discrimination testing, also demonstrated a nearly normal restoration of the medial plantar flap's sensitivity after a year. Patients see a gradual recovery of their sensitivity approximately four months following the procedure. Patient satisfaction is consistently at its highest level in all instances. Therefore, we can conclude that the innervated medial plantar fasciocutaneous flap, with its resilience, innervation, and area-like texture, is the best option for repairing soft tissue abnormalities in the heel. They have the ability to take control and provide support for the body's weight. Experiencing a few negative effects at the site where tissue is taken from (4).

Conclusions:

medial plantar fasciocutaneous flap is a highly effective method for repairing heel soft tissue injuries. This technique is particularly advantageous since it uses skin that is resistant to pressure and has a nerve supply while causing minimal harm to the area where the skin is taken from. The product offers consistent, long-lasting, and sensitive smooth skin with few complications and long-term effectiveness. The sensate flap is superior to the free flap in terms of both time and operational expense

Conflicts of Interest:

- The authors declare no conflicts of interest related to this study

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إعادة بناء الكعب بواسطة السديله الاخمصية الأنسية

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الملخص:

التمهيد: يعتبر الكعب ذو خاصية تشريحية مميزة فهو يعمل كأداة رئيسية في تحمل وزن الجسم، وأي اختلال في الكعب يؤدي إلى انعدام التوازن في المشي، ولذلك يجب أن تكون الأنسجة المستخدمة لإعادة بناء نسيج منطقة الكعب ذات مقاومة، وذات تحكم عصبي عالي، ومهيئة للتكيف مع وزن الجسم. إن الدراسة تهدف إلى تقييم مدى فعالية ونتائج إعادة بناء الكعب بواسطة السديله الاخمصية الأنسية في استعادة الوظيفة الحركية والحسية لدى المرضى المصابين بفقد نسيج الكعب.

المنهجية: الدراسة عبارة عن سلسلة حالات مستقبلية وصفية أجريت خلال الفترة من 2020-2024، في أربعة مستشفيات، لعدد 26 مريضاً عانوا من فقدان في انسجة كعب القدم. وقد خضعوا جميعهم لعملية إعادة بناء الكعب بواسطة السديله الاخمصية الأنسية

النتائج: شملت الدراسة 26 مريضا، معظمهم من الذكور (92.3 %) والباقي (7.7 %) من الإناث، وكان متوسط عمر المشاركين (35.42) سنة، وكان معظم المرضى الذين يعانون من فقدان في نسيج العكب بحجم أكبر من 3 سم (76.9 %)، مع قرحة غير تغذوية عصبية المنشأ في (73.1 %). وكان المعدل الإجمالي لديمومة عمر السديله (96.15 %) ومع معدل حصول مضاعفات (19.15 %) وتم إعادة اجراء العملية (11.5%)، وهذه المضاعفات المتوقعة الحدوث تنخر السديله الكلي (3.8 %) وتنخر السديله الجزئي (3.8%). موقع الجهات المانحة للجلد تمت تغطيته بزراعة الجلد مشطور السماكة، مع حدوث بعض المضاعفات مثل فقدان الجلد المزروع الجزئي/التي تلتئم بطريقة ثانوية (7.7 %)، بيمنا احتاج (3.8 %) الى إعادة العملية بسبب الفقدان الكلي للجلد المزروع.

الاستنتاجات: إن استخدام السديله الاخمصية الانسية لإعادة ترميم انسجة الكعب المفقودة

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هي تقنية تتميز بقدرة عالية على التكيف ويُنظر إليها على نطاق واسع على أنها أحد أفضل الخيارات لإعادة ترميم الفقد في انسجة الكعب. ويعزى ذلك إلى قدرته الفائقة على استبدال المنطقة المتضررة بنسيج مماثل ذو وظيفة حسية معتمدة على المبدأ الأساسي "استبدال النسيج المثل بالمثل".

الكلمات المفتاحية: فقدان نسيج الكعب، إعادة بناء الكعب، السديله الاخمصية الانسية