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# Frequency of Sensory Deficit in Terms of Two Point Discrimination in Split Thickness Skin Grafts and Local Flaps for Soft Tissue Defects of Fingers

**Suleman Fazal[1], Hasina Jan[1], Matiullah Khan[1], Saud Ahmed[1], Mariam Naseer[1], Ajmal Khan Kakar[1]**

[1]Department of Plastic Surgery and Burns, Bolan Medical Complex Hospital, Quetta, Pakistan

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**Correspondence to:** Suleman Fazal, Department of Plastic Surgery and Burns, Bolan Medical Complex Hospital, Quetta, Pakistan.
Email: sfjalalzai@gmail.com

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## ABSTRACT

**Introduction:** Finger injuries that involve soft tissues can be traumatic, burn, or infection, and necessitate successful reconstruction in order to alter performance and sensation. The gold standard of sensibility examination is two-point discrimination and is central to fine motor activities. The most common reconstructive methods include split-thickness skin grafts (STSGs) and local flaps, and their sensory results vary greatly. **Objective:** To investigate the incidence of sensory loss with regard to two-point discrimination of post-reconstruction skin gaps in the finger soft tissues with reconstruction using split-thickness skin grafts and local flaps. **Material and Method:** The study was a descriptive cross-sectional study carried out at Department of Plastic Surgery and Burns, Bolan Medical Complex Hospital Quetta, Pakistan from 18th March, 2025 to 19th June, 2025. Sixty patients aged 18 to 60 with finger soft tissue defects were recruited and split into STSG and local flap groups. Exclusion criteria included diabetes, peripheral neuropathy, and previous surgery on the same digit. Reconstruction was performed according to defect characteristics. Sensory evaluation using static two-point discrimination was done at 12 weeks postoperatively, with results categorized as normal (≤6 mm), fair (6–10 mm), or poor (>10 mm). **Results:** In the STSG group, only 20% achieved normal discrimination, while 46.7% showed poor outcomes. In contrast, 46.7% of local flap patients had normal sensation, with only 16.6% demonstrating poor recovery. **Conclusion:** Local flaps provide superior sensory recovery compared to STSGs. Although grafts remain useful for coverage, flaps are preferable when functional sensibility is critical.

## INTRODUCTION

Finger soft tissue injuries are some of the most frequent injuries that are experienced in hand trauma and reconstruction. These defects can be caused by crush injuries, avulsions, burns, infections, or tumor removals, which all damage the functional and sensory abilities of the hand. The treatment of these injuries predominantly includes coverage procedures, including split-thickness skin grafts (STSGs) and local or regional flaps, which have their benefits and constraints (1). The re-establishment of sensibility, especially the two-point discrimination, is the highest priority, since fine tactile function is critical in activities of daily living. Past clinical experiences have shown that local flaps and STSGs are inconsistent concerning sensory recovery, where flaps tend to have better sensibility, and grafts offer a less technically demanding solution. Moreover, the review literature also compared random pattern flaps with axial pattern flaps, and they revealed that there is a significant difference in sensory recovery between random pattern and axial pattern flaps, and axial pattern flaps perform better in tactile acuity preservation (2).

Additionally, current developments in fingertip regeneration protocols highlight conservative protocols that attempt to restore functional and sensory recovery to the best of their abilities without involving the extensive utilization of surgical protocols, adding further items to the list of procedures that can be adopted by the surgeons (3). Sensory performance in hand reconstruction has been indirectly related to broader neurological processes, such as cognitive disorders in the absence of sensory perception, and this reflects the interaction between the peripheral and central nervous systems (4). Sensory integration and pain modulation also have a major role in determining patient outcomes after reconstructive procedures. The studies conducted in spinal cord stimulation have indicated that manipulated frequency stimulation can potentially lead to a major outcome on the sense perception and functional recovery, especially in neuropathic conditions (5). These results suggest the importance of the fact that sensory reconstruction after the soft tissue reconstruction of the fingers is not just the question of viability of the tissue, but a complicated neurophysiological process.

This is particularly true in geriatric patients, where sensory impairment has been put forward as one of the natural aging effects, and its result is less predictable in the older cohort (6). Further, frequency-based interventions showed high-frequency trial of diabetic neuropathy spinal cord stimulation in terms of its sustainability and effectiveness in recovery of sensory functions, implying that there is a similarity in surgery to restore discriminative sensation in finger defects (7). The presence of any health-related quality of life improvement after sensation restoration with the assistance of such modalities also contributes to the emphasis on the value of tactile recovery in hand-performance (8). Additionally, its systemic conditions mean that sensory gating in children with autism spectrum disorders is directed to central filtering of perception of touch as a neurocognitive construct of why some children with autism may rebound tactile functions better than others following reconstructive work.

The surgical and anatomical complexity of soft tissue reconstruction of fingers must be met with innovative approaches to maximize both the coverage and functional outcomes (9). Complex techniques, including partial toenail flap transfer, have been effectively used as an intervention in reconstituting composite defects of the distal finger, with encouraging results in structural and sensory restoration (10). Equally, artificial dermis in combination with skin grafting has been reported as a useful technique in treating complex defects that expose the tendons or bones to guarantee durability and functional restoration (12). Comparative analysis is still able to prove that axial pattern flaps perform better than random pattern flaps in terms of establishing better sensory recovery, which affirms the notion that vascularized tissue with intact neurovascular components can play a larger role in discriminative sensation (12). In accordance with these findings, free fibular great toe neurovascular flaps have also been used successfully, particularly in distal finger reconstructions where both sensibility and durability are needed. Furthermore, smaller free flaps tailored to hand and finger defects have been linked to consistent results that give functional integrity and sensibility of difficult reconstructive cases (13).

The reconstruction of tactile sensibility in parts of the body, like the thumb pulp, which are vital in precision grip, is a major challenge in the field of finger reconstruction. It is reported that the first dorsal metacarpal artery island flap is effective in restoring sensibility in these reconstructions, demonstrating the significance of neurovascular flaps in functional outcomes (14). Comparisons of patient-reported outcomes of innervated and non-innervated glabrous skin flaps in volar digital defects have also shown huge differences, with the innervated flaps having better tactile function and patient satisfaction (15). More refinements in the reconstructive approach are the incorporation of retrograde island flap bridge transfers that combine vascular pedicle tubular skin grafting to fill defects in finger pulp, besides improving sensory recovery. The aesthetic and functional appeal has also been highlighted in the application of second-layer palmar grafts to reconstruct fingertips that offer encouraging outcomes in terms of both cosmetic and sensory restoration (16). Finally, free lateral great toe flap-based algorithms have also been developed to overcome fingertip defects and offer a systematic method to ensure the best result in the process of reconstruction, considering functional and sensory results (17).

All of this evidence suggests that both STSGs and local flaps have the potential to cover defects of finger soft tissue, but that there is a critical difference in sensory recovery, especially in two-point discrimination (18). In particular, neurovascular or innervated flaps are more likely to yield better results than grafts, even though the latter is an easier and more accessible option. The combination of sophisticated microsurgical tools and novel designs of flaps is still being made to achieve better outcomes, but the uncertainty of patient-specific factors, including age, comorbidities, and the adaptability of the neurological system, implies that the outcomes cannot be predicted in every case (19). Thus, the assessment of the sensory deficit prevalence, namely, two-point discrimination, in patients who undergo reconstruction with STSGs and local flaps is essential to inform surgical decision-making and maximize patient care. The aim of the study is to find evidence on the comparative sensory performance of these methods with respect to the soft tissue defects of the fingers, and the final objective of the study is to add value to reconstructive strategies and patient quality of life (20).

**Objective:** To establish the incidence of sensory deficit in terms of two-point discrimination after reconstruction of finger soft tissue defects using split-thickness skin grafts and local flaps.

## MATERIALS AND METHODS

**Study Design and Setting:** Department of Plastic Surgery and Burns, Bolan Medical Complex Hospital Quetta, Pakistan.

**Duration of Study:** From 18th March, 2025 to 19th June, 2025.

**Inclusion Criteria:** They included patients of both genders, aged between 18 and 60 years, with soft tissue defects of the fingers that needed reconstruction using either split-thickness skin grafts or local flaps. They selected only those with traumatic or post-infective defects less than three weeks in duration. Patients should have been medically fit and have given informed consent.

**Exclusion Criteria:** Patients with systemic conditions affecting peripheral nerve function, such as diabetes mellitus, peripheral vascular disease, or neuropathies, were excluded. Cases with previous reconstructive surgery of the same digit, severe crush injuries with devascularization, or associated fractures requiring fixation were also excluded to ensure standardization of outcomes. Patients unwilling to participate were not enrolled.

**Methods:** All eligible patients underwent reconstruction either with split-thickness skin grafts or local flaps according to defect size, location, and surgeon preference. Standardized surgical techniques were employed under regional or general anesthesia. Postoperatively, all patients received routine wound care, splintage, and physiotherapy. Sensory assessment was conducted using static two-point discrimination testing at 12 weeks

postoperatively. A caliper was used to determine the smallest distance at which patients could distinguish two separate points applied to the reconstructed area. Values ≤6 mm were considered normal, 6–10 mm fair, and >10 mm poor. Demographic data, defect characteristics, reconstructive technique used, and two-point discrimination results were recorded in structured proformas. Data were analyzed using descriptive statistics, with results expressed as frequencies and percentages for categorical variables and means with standard deviations for continuous variables. The frequency of sensory deficit was calculated separately for graft and flap groups for comparison.

## RESULTS

A total of 60 patients were included in the study, with an equal distribution between the split-thickness skin graft (STSG) group (n=30) and the local flap group (n=30). The majority of patients were male (n=40; 66.7%), while females accounted for 20 cases (33.3%). The mean age of participants was 34.5 years (range 18–58 years). Baseline demographic details are presented in Table 1.

**Table 1**

*Demographic Distribution of Patients (N = 60)*

| Variable | Frequency |
|---|---|
| Total Patients | 60 |
| Male | 40 |
| Female | 20 |
| Mean Age (years) | 34.5 |
| STSG group | 30 |
| Local Flap group | 30 |

Soft tissue defects were distributed across all digits of the hand. In the STSG group, the index finger (26.7%) and ring finger (23.3%) were most frequently involved. In the local flap group, the thumb (23.3%) and little finger (20%) were more commonly affected. This variation highlights the different anatomical considerations influencing reconstructive choice. Table 2 shows the distribution of defects according to finger involvement.

**Table 2**

*Distribution of Defects by Finger Involvement*

| Finger Involved | STSG (n=30) | Local Flap (n=30) |
|---|---|---|
| Thumb | 6 | 7 |
| Index | 8 | 6 |
| Middle | 5 | 6 |
| Ring | 7 | 5 |
| Little | 4 | 6 |

The assessment of two-point discrimination in the STSG group revealed that only 6 patients (20%) achieved normal sensibility (≤6 mm), while 10 patients (33.3%) had fair outcomes (6–10 mm). The majority, 14 patients (46.7%), demonstrated poor recovery (>10 mm). These findings indicate a relatively high frequency of sensory deficit in the grafted group. Details are presented in Table 3.

**Table 3**

*Two-Point Discrimination Outcomes in STSG Group (n = 30)*

| Two-Point Discrimination | Frequency | Percentage (%) |
|---|---|---|
| Normal (≤6 mm) | 6 | 20.0 |
| Fair (6–10 mm) | 10 | 33.3 |
| Poor (>10 mm) | 14 | 46.7 |

In contrast, patients reconstructed with local flaps showed superior sensory recovery. Normal two-point discrimination was observed in 14 patients (46.7%), while 11 patients (36.7%) had fair outcomes, and only 5 patients (16.6%) had poor results. This demonstrates the advantage of vascularized and, in many cases, innervated tissue in restoring digital sensation (Table 4).

**Table 4**

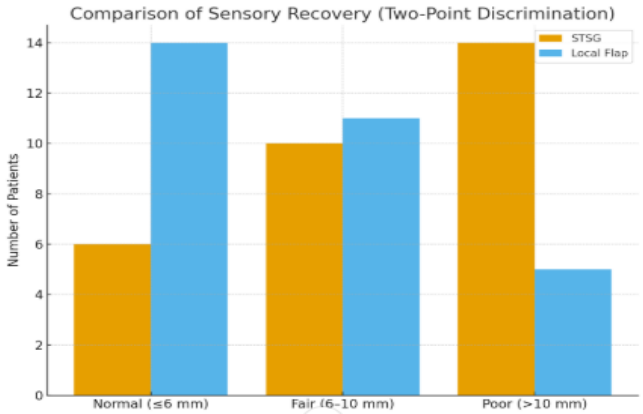
*Two-Point Discrimination Outcomes in Local Flap Group (n=30)*

| Two-Point Discrimination | Frequency | Percentage (%) |
|---|---|---|
| Normal (≤6 mm) | 14 | 46.7 |
| Fair (6–10 mm) | 11 | 36.7 |
| Poor (>10 mm) | 5 | 16.6 |

A graphical comparison of the two groups further highlights the differences in outcomes. As shown in Figure 1, local flaps were associated with nearly double the frequency of normal sensory recovery compared with STSGs, while poor recovery was markedly higher in the grafted group.

**Figure 1**

*Comparison of Two-Point Discrimination Outcomes between STSG and Local Flap Groups.*




Overall, these results demonstrate that local flaps provide superior restoration of sensory function in soft tissue defects of the fingers when compared with split-thickness skin grafts.

## DISCUSSION

The restoration of sensibility remains one of the most critical outcomes in hand and finger reconstruction. The findings of this study demonstrate that local flaps achieved better recovery of two-point discrimination compared to split-thickness skin grafts (STSGs), consistent with the widely accepted principle that vascularized and, ideally, innervated flaps restore tactile function more effectively (1). Previous studies have also shown that both local flaps and grafts are viable methods for covering digital defects, but their sensory outcomes differ significantly, with flaps having a greater capacity for functional recovery. Axial pattern flap has also been stated to be superior to random pattern flap in the maintenance of digital sensibility during comparative examination, underscoring the value of vascularity and innervation in the rehabilitation process of sensory organs (2). Moreover, conservative treatments of fingertip injuries, including new regeneration regimens, aim at the growing capacity to maximize natural sensory

performance, but cannot be applied to large defects (3). Neurology, too, has shown that the absence of perception, as in the case of such diseases as schizophrenia, puts into the fore the interactive nature of the central and peripheral processes in sensory integration (4).

The correlation between the neurophysiological functioning and the sensory outcomes is given in the body of literature on pain modulation and sensory perception. High-frequency spinal cord stimulation experiments have demonstrated that neuro-electrical circuit manipulation allows sensory recovery to be controlled, defining a coexistence in reconstructive surgery where tissue choice has a direct impact on the sensory outcome (5). There is also the digital reproduction of the signal that is complicated by recovery, which is often unpredictable in elderly patients, where there is reported deterioration of tactile performance due to age (6). The same findings are reported in the diabetic neuropathy literature, where frequency-based stimulation leads to prolonged sensation recovery, suggesting that personalized approaches to sensation recovery are relevant (7). These patients have mentioned quality-of-life gains following sensory enhancement that resonates with the feasible benefits of recovering fine tactile acuity in day-to-day activity (8). In addition, sensory gating research in autism showed that a few people may be naturally unable to process touch information, and this may have been the cause of the inconsistency of the surgical outcomes despite the best practices used in reconstruction (9).

A surgical innovation still forms the strategies that can be used in reconstructing fingertip and finger defects. An example of a toenail flap transfer (partially) has been mentioned with respect to distal finger defects, which involves structural coverage as well as possible sensory restoration (10). Correspondingly, the use of artificial dermis with grafting has been proposed in complex hand injuries with bone or tendon exposure, which showed promising structural results with limited sensory outcomes because it lacks innervation (12). Competitive experiments verify that axial pattern flaps provide superior sensory performance compared to random flaps, bolstering the argument in favor of more careful selection of flap type in digital reconstruction (13). Free fibular great toe neurovascular flaps further detail how the procedures of microsurgery have been tailored to provide sensibility and longevity to challenging cases (14). Finger-specific transfers of free tissues have proved to be reliable at a smaller scale in restoring form and functionality to add an extra pool of reconstructive choices (15).

The reconstructions of the thumb pulp are some of the most significant in terms of functionality and play a vital role in a precise grip. The neurovascular pedicled tissue has proven useful, with the island flap of the first dorsal metacarpal artery proving incredibly successful in reconstructing sensation in defects of the thumb (16,17). Other creative methods, including retrograde island flap bridge transfers, involve a combination of vascular pedicle grafting and skin transfers that optimize recovery of tactile function (18). There are also functional and aesthetic concerns that have informed methods such as second-layer palmar grafts, which offer a good balance of appearance and sensation, though not as high as those provided by neurovascular flaps (19). Lastly, algorithmic classifications, like those suggested in lateral great toe flap reconstructions, give surgeons guidelines in which to choose procedures, which balance both functional restoration and sensory recovery (20).

The present study confirms that STSGs, though technically simpler and more readily available, are associated with a higher frequency of sensory deficit compared to local flaps. Nearly half of patients in the STSG group demonstrated poor two-point discrimination outcomes, whereas only 16.6% of patients in the flap group had poor results. This aligns with prior findings that grafts provide mechanical coverage but lack neural components essential for discriminatory sensation (1,2,13). In contrast, flaps—especially innervated or neurovascular ones—carry their own vascular and neural supply, thereby significantly enhancing sensory recovery (14,16). The graph generated in this study further highlighted the stark difference in outcomes, making the case for favoring flaps in cases where sensibility is functionally critical.

Nevertheless, STSGs maintain their relevance in settings where resources, expertise, or donor tissue options are limited. Their ease of harvest, shorter operative times, and relatively uncomplicated postoperative care make them a practical solution, particularly in emergency or resource-constrained environments (12). However, in occupations or lifestyles where fine tactile discrimination is indispensable—such as manual labor, musicianship, or professional craftsmanship—the use of local or neurovascular flaps may be more appropriate. This necessitates a patient-specific approach, taking into account not only anatomical and clinical factors but also the patient's vocational and lifestyle demands.

Limitations of this study include its relatively short follow-up period of 12 weeks, which may not fully capture long-term sensory recovery, as reinnervation processes can extend over several months. Additionally, the study was limited to a single center, potentially restricting the generalizability of results (17). Future multicenter trials with longer follow-up and inclusion of patient-reported outcome measures could further clarify the role of different reconstructive methods in restoring digital sensibility. Advanced techniques, such as bioengineered grafts or nerve-integrated flaps, also warrant exploration as they hold the potential to bridge the gap between simple grafting and complex microsurgical flaps.

## CONCLUSION

The results of this study highlight a clear difference in sensory outcomes between split-thickness skin grafts and local flaps used for reconstruction of soft tissue defects of the fingers. Local flaps provided superior restoration of discriminatory sensibility, with nearly half of patients regaining normal two-point discrimination, while the majority of grafted patients demonstrated fair to poor recovery. This finding reinforces the principle that vascularized and, in many cases, innervated tissue is essential for functional recovery, as it preserves or restores the neural pathways necessary for tactile discrimination. Although grafts remain useful for simple coverage because of their ease, rapidity, and accessibility, they are limited by the absence of neural integration,

resulting in a higher frequency of sensory deficit. These findings suggest that whenever possible, local flaps should be considered the preferred option for reconstruction of finger soft tissue defects where fine sensibility is functionally critical. However, grafts maintain relevance in resource-constrained environments or in less demanding cases where structural coverage is the primary goal. A patient-centered approach, balancing defect characteristics, occupational needs, and available surgical resources, remains essential. Future research should focus on long-term outcomes and advanced reconstructive strategies, including innervated flaps and bioengineered grafts, to further optimize both aesthetic and functional recovery in digital reconstruction.

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