ORIGINAL ARTICLE

FREQUENCY OF SENSORY DEFICIT IN TERMS OF TWO POINT DISCRIMINATION IN SPLIT THICKNESS SKIN GRAFTS AND LOCAL FLAPS FOR SOFT TISSUE DEFECTS OF FINGERS

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Background: The minimum distance between two stimulus points on the skin, which are perceived as distinct points, is defined as two point discrimination (TPD). Among the two types of TPD, i.e., static and dynamic, static two-point discrimination (STPD) is commonly used to determine digital nerve integrity. Local flaps usually do well in maintaining sensibility of the covered area in terms of two-point discrimination in contrast to split thickness skin grafts (STSG). Aim was to determine the frequency of sensory deficit in terms of Two Point Discrimination (TPD) in Split Thickness Skin Grafts (STSG) and local flaps for soft tissue defects of fingers three months postoperatively. **Methods:** Thirty-five patients underwent local flap coverage and other thirty-five had split thickness skin grafting for soft tissue defects of fingers depending upon nature of defect. Patients were followed up at 2, 4, 8 and 12 weeks. TPD, measured at 3 months of follow-up, of 7 mm was considered normal (no sensory deficit) and TPD of 8mm or more was considered as sensory deficit. **Results:** The sensory deficit observed at the end of 12th week post operatively was 8.6% in the patients with local flap coverage (3 patients) and 45.7% with STSG (16 patients). Patients with no sensory deficit were 91.4% (32 patients) in the local flap coverage and 54.3% (19 patients) in the STSG at 12th week of follow up. The relative ratio (RR) of sensory deficit in local flaps and STSG was 5 (>2). **Conclusions:** Local flaps are better options in terms of TPD preservation as opposed to STSG for soft tissue defects of fingers.

Keywords: Finger Injuries, Two Point Discrimination, Split Thickness Skin Grafting, Local flaps

INTRODUCTION

Glories of creativity and modernisation of this mankind owe to the perfect design of strength, coordinated fine movements and specialised senses of the human hand.[1] Hands are most involved in ones daily activities, exposing them to trauma or injuries. Such injuries can vary from minor cuts to complex ones that encompass soft tissue defects, fractures, tendon cuts or even amputations.[2] While dealing with complex trauma of hand a detailed account of these injuries must be made before setting foot on treatment. Thus soft tissue defects of fingers require attention; not only to the coverage aspect but also the sensations that may be involved. One of these sensations, i.e., two point discrimination; is the ability of skin to differentiate two stimuli simultaneously.[3]

Testing two point discrimination (TPD) in human is relatively an easy clinical procedure.[4] TPD is divided into static (STPD) and dynamic (DTPD) types. Of these, STPD is commonly employed for determining digital nerve integrity in the emergency departments.[5] It is also recommended method of quantitative evaluation of loss of sensations[6–8], whereas DTPD is not routinely used. Various methods for measuring TPD include Calipers or an opened paper clip (for STPD),[9] aesthesiometer (for STPD), and Disk-Criminator (for DTPD).[10] Studies have suggested that properly calibrated paper clips perform as well as the Disk-Criminator.[2,9,11]

Various options for the soft tissue coverage of fingers range from simpler options of skin grafting (full or split thickness) and Local flaps (e.g., Z-plasty, V-Y advancement, cross finger flap etc.), to more complex options of regional, distant or free flaps.[1] These various options have different cosmetic and functional outcomes (motor and sensory function).

Skin grafts have a decreased number of mechanoreceptors unlike flaps that not only retain their blood supply but also a greater number of sensory receptors.[12] Skin grafting may be a simple procedure as compared to flaps but the local flaps not only have superior cosmetic results[1,13,14], they also prove to be better options in terms of blood flow and TPD.[12] This study focuses on determining the frequency of sensory deficit in terms of TPD, when local flaps or STSG are employed in the coverage of soft tissue defects of fingers.

MATERIAL AND METHODS

Patients of thirteen to sixty years age, belonging to either sex, with soft tissue defects of fingers, not more than 3 Cm, were included in the study. Diabetic patients with peripheral neuropathy or finger injuries involving neurovascular bundle were excluded from study.

Fasciocutaneous local flaps obtained from neighbouring finger or dorsum of hand or STSG were utilised to cover the soft tissue defects. Flaps were utilised for bare bone or tendons and STSG for finger defects involving skin and subcutaneous layer only.

The flap donor sites were closed primarily or covered with split thickness skin graft. Postoperatively TPD was assessed by using pre-bent set of paper clips set at a distance of 7 and 8 mm, at the flap and the STSG at 2, 4, 8, and 12 weeks. Values up to 7 mm were considered as normal while values equal to or more than 8 mm were considered as sensory deficit. Effect modifiers like mode of injury, nature and size of defect were addressed through stratification.

The data were analysed using SPSS-10. The relative ratio (RR) was evaluated to see the strength of association of TPD between the two groups and RR >2 considered significant.

RESULTS

A total of 70 patients underwent surgery on the basis of soft tissue defect of fingers. The frequency of male gender was 45 (64.3%) and female gender was 25 (35.7%). The frequency of age was highest in age group of 10–20 years with frequency of 35 (50%) and was least in the age group of 41–50 years with frequency of 2 (2.85%) with a mean of 22.47 ±11.431) (Table-1).

The frequency and percentages of mode of injury being 21 (30%) for trauma, 32 (45.7%) for burns and 17 (24.3) for others causes. The frequencies and percentages for nature of defects were 43 (61.4%) for skin only, 23 (32.9%) for tendons deep and 4 (5.7%) for bone deep defects (Table-2).

The frequency and percentages for size of defect was 5 (7.1%) for 0–1 Cm, 47 (67.1%) for 1.1–2 Cm, and 18 (25.7%) for defects of 2.1–3 Cm. The frequencies and percentages for the location of the soft tissue defect were 26 (37.1%) for proximal phalanx, 34 (48.6%) for middle phalanx and 10 (14.3%) for distal phalanx (Table-3).

The sensory deficit observed at the end of 12th week post operatively was 8.6% in local flap coverage (3 patients) and 45.7% with STSG (16 patients). Patients with no sensory deficit were 91.4% (32 patients) in the local flap coverage and 54.3% (19 patients) in the STSG at 12th week of follow up. The relative ratio of sensory deficit in local flaps and STSG was 5 (>2) (Table-4). Patients, who underwent STSG, suffered more sensory deficit in terms of TPD as opposed to patients with local flap coverage for their soft issue defects.

The sensory deficit was observed to be the least in patients whose mode of injury was trauma (21.1%) and other (5.3%) and was the greatest in patients with burns (73.7%) (Table-5).

Table-1: Distribution of patients in groups

Age group (yeas)	Frequency	Percentage
10–20	35	50.0
21–30	22	31.42
31–40	8	11.42
41–50	2	2.85
>50	3	4.3

Table-2: Distribution according to mode of injury

Variable	Frequency	Percent
Mode of Injury		
Trauma	21	30.0
Burns	32	45.7
Others	17	24.3
Nature of defect		
Skin only	43	61.4
Tendons bare	23	32.9
Bone deep	4	5.7
Total	70	100.0

Table-3: Distribution according to size and location

Variable	Frequency	Percentage
Size of defect		
0–1 Cm	5	7.1
1.1–2 Cm	47	67.1
2.1–3 Cm	18	25.7
Location		
Proximal phalanx	26	37.1
Middle Phalanx	34	48.6
Distal Phalanx	10	14.3

Table-4: Sensory deficit in flaps and grafts [n(%)]

Operative procedure (soft tissue cover)	Sensory deficit		Total
	Present	Absent	
Flap	3 (8.6)	32 (91.4)	35
Graft	16 (45.7)	19 (54.3)	35
Total	19 (27.1)	51 (72.9)	70

Table-5: Sensory deficit vs mode of injury [n(%)]

Sensory deficit	Mode of injury			Total
	Trauma	Burns	Others	
Present	4 (21.1)	14 (73.7)	1 (5.3)	19
Absent	17 (33.3)	18 (35.3)	16 (31.4)	51
Total	21 (30.0)	32 (45.7)	17 (24.3)	70

DISCUSSION

Reconstruction of hand injuries is not only aimed in the restoration of aesthetics but primarily in the restoration of motor as well as sensory function of hand. The sensory testing of the hand includes dermatomal assessment for sensations like touch (light/deep), pain, pressure, vibration, temperature, TPD, and cortical sensations.[3] TPD has been suggested as a reliable quantitative measure of sensibility.[15,16] The TPD test was originally used for innervations density test of afferent fibers.[17,18] Although method is subjective, it is more reliable than previously available methods and is a quantitative measure of the sensory loss.[6]

Two-point discrimination testing in human subjects is a reasonably easy clinical procedure and the most reliable method available for evaluating tactile gnosis in human subjects.[4] Skill and technique in two-point testing obviously play a significant part in assuring accuracy and reliability of test results.

TPD is effectively utilised for determining the digital nerve integrity and neuropathy in diabetes mellitus patients. Aberg *et al*[19] determined that TPD is a reliable objective method for evaluating sensory recovery after peripheral nerve repair. This observation was also supported by Shooter.[11]

In this study TPD is employed as a tool for testing neuropathy after soft tissue reconstruction of fingers. Orhun *et al*[20] determined recovery of TPD in soft tissue defects of finger tips using local flaps and quantified TPD of 6–8 mm as being within acceptable limit. In this study TPD below 7 mm is considered normal and TPD above or equal to 8mm is considered as sensory deficit.

According to Dellon[10] in terms of desirability of the testing device, tip geometry and translation of inter-prong distance to numerical rating scale, the paper clip was judged to be less favourable test device than the Disk-Criminator™. However, Shooter[11] and Bleyenheuft[2] have stated paper clip method as a reliable tool for determining TPD with inter examiner reliability. Finnell *et al*[9] also concluded that a properly calibrated set of paper clips performed as well as the Disk-Criminator™. In this study TPD was determined using a pre-bent set of paper clips due to easy availably and reliability of this testing tool.

Sensory return in a split skin graft is an important factor in the protection of this graft from injury. Nedelec[4] demonstrated that the skin sensations do not return to normal levels after skin grafting in burn survivors. The elevation of thresholds and reduction of sensory intensity is accompanied by a general decrease in the density of nerve terminals. The lack, or numerical reduction of sweat glands and innervated blood vessels have been found to be indicative of diminished sensation on grafted skin.[4] In this study the sensory deficit was found to be greatest in the patients with burns, i.e., 73.7%.

Skin grafts face the problem of decreased number of mechanoreceptors unlike flaps that not only retain their blood supply but also a greater number of sensory receptors. This observation has been demonstrated by Schliephake *et al* [12] that the rate of both blood flow and two-point discrimination on the surface of local flaps and island flaps was not statistically different from the corresponding area of the unoperated side. Free skin grafts exhibited incomplete restoration of thermal sensibility.

Ali J[21] reported that grafted skin did not recover pinprick sensation, even 15 years after surgery. Scott *et al*[22] found out that the impaired thermoregulatory function in grafted skin was due to loss of vasodilatation and sweat glands. In this study it has been seen that TPD did not return to normal in 45.7% of skin graft patients over a period of three months follow up. However, Omer *et al*[23] and Krag C[24] showed that the TPD may suffer an early preservation followed by later decrease in sensibility. In this study such findings were not encountered due shorter period of follow up.

Nicolai and Hentenaar[25] examined cross finger flap patients postoperatively, with particular reference to two-point discrimination and concluded that it significantly improved over time. Orhun *et al*[20] demonstrated 76.47% of static two point discrimination recovery in their patients who underwent thenar and cross finger flaps. However, they only had deficit of 5.8% for DTPD. In this study, 91.4% of patients who underwent local flap coverage for soft tissue defects did not have sensory deficit in terms of TPD. However, 8.6% of patients did demonstrate sensory deficit in terms of TPD.

Rose *et al*[26] achieved similar results for TPD between free flaps and skin grafts. The overall sensory deficit of TPD was 41.17% in skin graft cases with an average TPD of 7 mm. Similar results have been obtained in this study with TPD sensory deficit of 45.7% in patients treated with skin grafts. This study shows that two point discrimination with use of local flaps for soft tissue defects of fingers resulted in sensory deficit of 8.6% in contrast to skin grafts that showed a deficit of 45.7%.

CONCLUSION

The results of this study show local flaps better options in terms of preservation of two point discrimination as opposed to STSG for soft tissue defects of fingers.

REFERRENCES

1. Thorne CH. Plastic surgeons and the development of hand surgery. In: Thorne CH. Grabb and Smith's Plastic Surgery. 6th ed. Philadelphia: Lippincott Williams & Wilkins; 2007.p. 756–9.
2. Bleyenheuft Y, Thonnard JL. Tactile spatial resolution measured manually: a validation study. Somatosens Mot Res 2007;24:111–4.
3. Hu H, Zhang D. Classification of finger flaps and its use in emergency treatment for finger injuries. Zhongguo Xiu Fu Chong Jian Wai Ke Za Zhi 2006;20:1196–8.
4. Nedelec B, Hou Q, Sohbi I, Choiniere M, Beauregard G, Dykes RW. Sensory perception and neuroanatomical structures in normal and grafted skin of burn survivors. Burns 2005;31:817–30.
5. Marcus F, Rodriguez L, Fels K. New method for evaluation of cutaneous sensibility in diabetic feet: preliminary report. Rev Hosp Clin Fac Med Sao Paulo 2004;59:286–90.
6. Periyasamy R, Manivannan M, Narayanamurthy VB. Correlation between two-point discrimination with other measures of sensory loss in diabetes mellitus patients. Int J Diab Dev Ctries 2008;28:71–8.
7. Periyasamy R, Manivannan M, Narayanamurthy VBR. Changes in Two Point Discrimination and the law of mobility in Diabetes Mellitus patients. J Brachial Plex Peripher Nerve Inj 2008;29:121–5.
8. Nes SIV, Faber CG, Hamers RMTP, Harschnitz O, Bakkers M, Hermans MCE, *et al*. Revising two-point discrimination assessment in normal aging and in patients with polyneuropathies. J Neurol Neurosurg Psychiatry 2008;79:832–4.
9. Finnell JT, Knopp R, Johnson P, Holland PC, Schubert W. A calibrated paper clip is a reliable measure of two-point discrimination. Acad Emerg Med 2004;11:710–4.
10. Dellon ES, Keller KM, Moratz V, Dellon AL. Validation of Cutaneous pressure threshold measurements for the evaluation of hand function. Ann Plast Surg 1997;38:485–92.
11. Shooter D. Use of two-point discrimination as a nerve repair assessment tool: preliminary report. ANZ J Surg 2005;75:866–8.

12. Schliephake H, Schmelzeisen R, Neukam FW. Long-term results of blood flow and cutaneous sensibility of flaps used for the reconstruction of facial soft tissues. J Oral Maxillofac Surg 1994;52:1247–52.
13. Hussain S, Khan MI, Khan MA, Chaudary TH, Ahmed Z. Management of soft tissue defects of hand with local (posterior interosseous) flaps. Ann King Edward Med Uni 2005;11:228–31.
14. Satish C, Nema S. First dorsal metacarpal artery islanded flap: A useful flap for reconstruction of thumb pulp defects. Indian J Plast Surg 2009;42:32–5.
15. Dellon AL. Computer-assisted sensibility evaluation and surgical treatment of tarsal tunnel syndrome. Adv Podiatry 1996;2:17–40.
16. Dellon ES, Keller KM, Moratz V, Dellon AL. Validation of cutaneous pressure threshold measurements for the evaluation of hand function. Ann Plast Surg 1997;38:485–92.
17. Suzuki S, Shin'ichi H, Junsuke S, Masahiro T, Yoshiyuki Y, Takeshi K. Clinical Experiences with the Modified Thenar Flap Method for 16 Fingertip Injury Cases. Jpn J Plast Reconstr Surg 2003;46:407–12.
18. Johansson RS, Vallbo AB. Tactile sensibility in the human hand: Relative and absolute densities of four types of mechanoreceptive units in glabrous skin. J Physiol 1979;286:283–300.
19. Aberg M, Ljungberg C, Edin E, Jenmalm P, Millqvist H, Nordh E, *et al*. Considerations in evaluating new treatment alternatives following peripheral nerve injuries: a prospective clinical study of methods used to investigate sensory, motor and functional recovery. J Plast Reconstr Aesthet Surg 2007;60:103–13.
20. Orhun E, Polatkan S, Nuzumlali E, Kantarci U, Polatkan O. Evaluation of sensory recovery of thenar and cross finger flaps used in finger tip injuries. Acta Orthop Traumatol Turc 2000;34:59–63.
21. Ali J. Sensory recovery in a split skin graft: Pinprick or a thermal sensory analyzer. Plast Reconstr Surg 2002;109:562–5.
22. Scott DL, Shibasaki M, Low DA, Cui J, Keller DM, Purdue GF, *et al*. Impaired Cutaneous Vasodilatation and Sweating in Grafted Skin During Whole-Body Heating. J Burn Care Res 2007;28:427–34.
23. Omer GE. Day DJ, Hubert R, Lambert P. Neurovascular Cutaneous Island Pedicles for Deficient Median-Nerve Sensibility-new Technique and Results of Serial Functional Tests. J Bone Joint Surg 1970;52:1181–92.
24. Krag C, Rasmussen KB. The Neurovascular Island Flap for Defective Sensibility of the Thumb. J Bone Joint Surg Br 1975;57:495–9.
25. Nicolai JPA, Hentenaar G. Sensation in Cross-Finger Flaps. Hand 1981;13:12–6.
26. Rose EH, Norris MS, Kowalski TA. Microsurgical management of complex fingertip injuries: comparison to conventional skin grafting. J Reconstr Microsurg 1988;4:89–98.

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