THE HETERODIGITAL NEUROVASCULAR ISLAND FLAP: A SENSIBLE SOLUTION FOR DIFFICULT DIGITAL DEFECTS

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ABSTRACT
A presentation is made of 6 cases with sizable soft-tissue defects of the digits that pose difficulty in reconstruction. The heterodigital neurovascular island flap allowed coverage of these difficult defects including the pulp with glabrous, sensitive, supple, and well-vascularized skin in one operative stage. Restoration of sensory discrimination was achieved with a near normal two-point discrimination in the reconstructed digits. Acceptable function was obtained in the reconstructed as well as in the donor digits. This procedure is indicated for extensive digital defects (e.g. degloving injuries) in which reconstruction cannot be done using other flaps and as an alternative to microsurgical reconstruction especially when the amputated segment is destroyed by the initial trauma.

Key Words: Heterodigital island flap-extensive digital defects-degloving injuries-restoration of sensory discrimination.

INTRODUCTION
Extensive digital defects involving the tactile surface of the digits (e.g. digital degloving injuries) represent a challenging problem to the reconstructive surgeon. Restoration of sensory discrimination in such injuries is of crucial importance to maintain and restore proper function of the hand. The heterodigital neurovascular island flap is a useful solution in this context. In 1952 Littler was the first to cut the skin edge in pollicization and thus create a true island flap in the hand. The heterodigital neurovascular island flap was first proposed by Moberg in 1955. In 1956 it was performed by Littler, and the first series of standardizing the technique were reported by Littler in 1960 and Tubiana and Duparc in 1961.

PATIENTS & METHODS
From October 2003 till January 2005, 6 patients were operated upon using the heterodigital neurovascular island flap to cover extensive digital defects involving the tactile surfaces of the fingers. All patients were males, 4 of them were manual workers and 2 were students. The average age was 22 years (range 12 to 45 yrs.). Three patients presented with a degloving injury involving the ring finger, one patient with a degloving injury involving the little finger, one patient with loss of the volar aspect of the index finger from the mid of the proximal phalanx up to the tip, and one patient with crushing of the ulnar aspect of the little finger.

All of these patients presented without the degloved or crushed part of the digit that had been completely destroyed by the trauma, thus abolishing any chance for replantation.

The size of the defects ranged from: 3 x 2 cm to 5 x 5.5 cm. Follow up ranged from 16 months to 1 month. Table (1).
Table (1): Patients

<table>
<thead>
<tr>
<th>No.</th>
<th>Age</th>
<th>Sex</th>
<th>Occupation</th>
<th>Injury</th>
<th>Finger</th>
<th>Size of defect</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>25y</td>
<td>M</td>
<td>manual worker</td>
<td>degloving</td>
<td>ring (lt.)</td>
<td>5 x 5.5 cm</td>
</tr>
<tr>
<td>2</td>
<td>17y</td>
<td>M</td>
<td>manual worker</td>
<td>degloving</td>
<td>little (lt.)</td>
<td>2.5 x 5 cm</td>
</tr>
<tr>
<td>3</td>
<td>45y</td>
<td>M</td>
<td>manual worker</td>
<td>crushing</td>
<td>index (lt.)</td>
<td>3 x 2 cm</td>
</tr>
<tr>
<td>4</td>
<td>19y</td>
<td>M</td>
<td>manual worker</td>
<td>sawing machine</td>
<td>little (rt.)</td>
<td>4 x 1.5 cm</td>
</tr>
<tr>
<td>5</td>
<td>12y</td>
<td>M</td>
<td>student</td>
<td>degloving</td>
<td>ring (rt.)</td>
<td>4.5 x 5 cm</td>
</tr>
<tr>
<td>6</td>
<td>16y</td>
<td>M</td>
<td>student</td>
<td>degloving</td>
<td>ring (rt.)</td>
<td>4.5 x 5 cm</td>
</tr>
</tbody>
</table>

Operative Technique (Fig.1)

Anesthesia:
General endotracheal + tourniquet

Planning:
A template of the size of the defect to be covered by the flap is taken and the dimensions of the flap are drawn on the ulnar non-dominant side of the adjacent finger. A mid-lateral or zigzag incision is continued on the rest of the finger to allow dissection of the neurovascular bundle.

A further zigzag incision is drawn on the distal aspect of the palm to allow dissection of the neurovascular bundle up to the level of the superficial palmar arch.

Debridement and jet lavage of the injured finger.

Flap elevation:
This is started from distal to proximal and from volar to dorsal to allow proper visualization and dissection of the neurovascular bundle. The neurovascular bundle is dissected carefully with a cuff of fibro-fatty tissue up to the superficial palmar arch.

Creation of a subcutaneous tunnel and insetting of the flap:
The tunnel should be wide enough to allow easy passage of the flap and avoid compression of the neurovascular bundle.

Harvesting of a FTG from the ulnar border of the palm:
This FTG is used to resurface the donor site defect with similar type of tissue.

Harvesting of a FTG from the wrist or elbow crease or from the abdomen:
This FTG is used to cover the dorsal aspect of the finger in cases of degloving injuries.

Fashioning of a tie over dressing:
This is used to dress the donor site and the dorsal aspect of the degloved finger.
RESULTS

Viability: All flaps showed excellent viability with no single case of flap loss, partial necrosis or superficial sloughing.

Sensibility: was preserved in all flaps with a static TPD ranging from 4 mm to 7 mm. It was shown to be almost comparable to the TPD of the contralateral normal finger. No progressive deterioration in sensibility was noticed after more than one year of follow up. Cortical reintegration was not achievable however except in one case (12 yrs.)

Normal range of motion was regained in all donor digits within a period of 4-6 weeks. The range of flexion however was slightly limited in three of the reconstructed digits.

The patients could achieve acceptable function and return to work within a period of 4-6 weeks.

Complications:

1-Donor site morbidity:
- hypothesia of the ulnar aspect of the donor digit
- hyperpigmentation occurred in one FTG taken from the abdomen.

2-Cold intolerance: has been reported in one case in the reconstructed finger.

3-Partial loss of one FTG on the dorsum of a reconstructed degloved finger with spontaneous healing after 2 weeks.

Table (2): Results

<table>
<thead>
<tr>
<th>No.</th>
<th>Viability</th>
<th>Sensibility (static TPD)</th>
<th>Range of motion (donor)</th>
<th>Range of motion (recip.)</th>
<th>Complications</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>100%</td>
<td>5 mm</td>
<td>normal (4 w)</td>
<td>normal</td>
<td>-hyperpigmentation of FTG -cold intolerance</td>
</tr>
<tr>
<td>2</td>
<td>100%</td>
<td>7 mm</td>
<td>normal (6 w)</td>
<td>limited flexion</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>100%</td>
<td>4 mm</td>
<td>normal (6 w)</td>
<td>normal (6 w)</td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>100%</td>
<td>5 mm</td>
<td>normal (4 w)</td>
<td>limited flexion</td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>100%</td>
<td>5 mm</td>
<td>normal (4 w)</td>
<td>normal</td>
<td>partial loss of FTG</td>
</tr>
<tr>
<td>6</td>
<td>100%</td>
<td>5 mm</td>
<td>normal (4 w)</td>
<td>limited flexion</td>
<td></td>
</tr>
</tbody>
</table>

Fig. (1):
- Planning of the flap-volar view.
- Planning of the flap-dorsal view.
- Flap elevation.
- Dissection of the neurovascular bundle.
- Insertion of the flap after tunneling and showing site of harvesting of donor site graft (ulnar border of the hand) and site of harvesting of graft for dorsal aspect of the degloved finger (wrist crease)
- Grafting of donor site and dorsal aspect of degloved finger.
Fig. (2): Case 1. (Above row) Ring avulsion injury of lt. ring finger. (Second row) Elevation and insetting of the flap and grafting of donor site and dorsal aspect of the finger. (Lower rows) Postoperative result after more than one year with good flexion of donor and reconstructed
Fig. 3: Case 2 (Above row) Degloving injury of the lt. little finger-volar view-side view-dorsal view-volar view. (Central row) Elevation of the flap. (Below row) Postoperative result after more than one year with defective flexion of the reconstructed digit.
Fig. (4): Case 3 (Above row) crushing injury of the lt. index finger. (Central row) Elevation of the flap. (Below row) Postoperative result after more than one year with good flexion of the donor and reconstructed digit.
DISCUSSION

The fingertip is the end organ for touch and is richly supplied with special sensory receptors that enable the hand to "see", relaying the shape, texture and temperature of manipulated objects. Complex digital injuries involving the loss of fingertip sensibility, as in case of digital degloving, pose challenging problems for hand surgeons. The reconstructive goal must include restoration of sensibility if maximal function is to be achieved.

Some authors have concluded that a degloved finger, with the exception of the thumb, should be a candidate for amputation in the interest of total hand function. Although this line of management allows early healing and rapid return to work, yet it is obviously suboptimal as regards the overall function of the hand and the final esthetic appearance.

Distant flaps have been used in the management of the degloved finger and specially the thumb. The infra-clavicular region in the male and the inguinal region in the female had been advocated. Distant flaps however exhibit significant drawbacks. First of all they require more than one operative stage adding physical and psychological burdens to the patient and placing a greater economic burden on the health authorities.

Secondly, they require a period of immobilization of the recently injured hand with the inherent risks of stiffness particularly in the older age groups. In addition they provide less than ideal tissue for reconstruction in terms of thickness, color, and texture. Lastly and most important they offer no sensibility to an area of the body where sensation is of crucial importance.

In contrast, replantation offers a promising solution in some degloving injuries, and the functional and esthetic results may be more acceptable than amputation or tubed distant flaps.

Unfortunately the amputated segment is not always available for replantation. The heterodigital neurovascular island flap allowed restoration of excellent sensibility to the injured digits as evidenced by a TPD comparable to the contralateral normal digit. The absence of cortical reintegration did not impair or limit the function of the hand in any way. Progressive deterioration of sensibility reported by others was not noted in any of our cases after a follow up period of more than one year.

In addition the quality of tissue restored to the injured digit is quite similar to the one lost in terms of color and texture match, thus fulfilling the goal of "replacing like with like".

Being elevated from the ulnar and dorsal aspect of the adjacent finger, the donor digit did not suffer any functional impairment due to preservation of optimal sensibility in the radial critical border of the digit that is directly involved in opposition with the thumb. Compared to distant flaps and the innervated cross finger flap the heterodigital neurovascular island flap is a one stage procedure with rapid return of function allowing the patient to resume work expediently and obviating the need for prolonged immobilization with its inherent risks of joint stiffness.

The flap has shown to be simple in its elevation and extremely reliable with consistent results as regards viability and sensibility without the need for sophisticated microvascular techniques that obviously require more operative time.

CONCLUSION

The heterodigital neurovascular island flap allows coverage of difficult digital defects including the pulp with glabrous, sensitive, supple, and well-vascularized skin in one operative stage.

The procedure is indicated for extensive digital defects in which reconstruction cannot be done using other flaps and as an alternative to microsurgical reconstruction especially when replantation is not feasible due to complete destruction of the amputated segment.

REFERENCES

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