

# Dorsolateral flap vs. radial midpalmar island flap in the treatment of traumatic distal thumb injuries. Clinical evaluation

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## ABSTRACT

**Objective:** To clinically evaluate patients with combined distal thumb lesions treated by a dorsolateral flap or radial midpalmar island flap. **Materials and methods:** We retrospectively compared 20 patients (14 males and 6 females, averaging 35 years) with combined distal thumb traumatic lesions, who were operated on by two surgeons using different techniques. Patients had no previous surgical history and a minimum follow-up period of 24 months. Subjective outcome was evaluated by satisfaction index (SI), visual analogue scale (VAS), and QuickDASH score. Objective outcome was evaluated by two-point discrimination test (TPDT), average surgical time (ST), and need for digital spatial reeducation (DSR). **Results:** Time from admission to medical discharge averaged 7 weeks (range, 6-8). Average postoperative results: VAS for pain, 01/10 (both groups); IS, 97% vs. 92% (dorsolateral flap group vs. radial midpalmar island flap); TPDT, 4 mm vs. 6 mm; QuickDASH, 2.5 vs. 8; ST, 45 minutes vs. 60 minutes; need for DSR, 0 vs. 4 cases. **Conclusion:** Both the dorsolateral flap and the radial midpalmar island flap techniques were effective in the treatment of distal thumb traumatic lesions, although the dorsolateral flap produced better results in terms of objective evaluation and required less ST.

**Key words:** Distal thumb lesions; dorsolateral flap; radial midpalmar island flap.

**Level of Evidence:** III

## Colgajo dorsolateral versus colgajo en isla mediopalmar radial para el tratamiento de lesiones traumáticas distales del pulgar. Evaluación clínica

## RESUMEN

**Objetivo:** Evaluar clínicamente a pacientes con lesiones distales combinadas del pulgar tratados mediante colgajo dorsolateral o colgajo en isla mediopalmar radial. **Materiales y Métodos:** Se comparó retrospectivamente a 20 pacientes (14 hombres y 6 mujeres; promedio de edad 35 años) con lesiones traumáticas combinadas distales del pulgar, operados por dos cirujanos, con técnicas diferentes. Los pacientes no tenían antecedentes quirúrgicos y el seguimiento mínimo fue de 24 meses. Se evaluaron el resultado subjetivo usando el índice de satisfacción, la escala analógica visual para dolor y el puntaje Quick DASH, y el resultado objetivo mediante el test de discriminación de 2 puntos, el tiempo quirúrgico promedio y la necesidad de reeducación espacial digital. **Resultados:** La media desde el ingreso hasta el alta laboral fue de 7 semanas (rango 6-8). Resultados promedio posoperatorios: escala analógica visual 01/10, ambos grupos. Grupo con colgajo dorsolateral: índice de satisfacción 97%, test de discriminación de 2 puntos 4 mm, puntaje QuickDASH 2,5; tiempo quirúrgico 45 min, sin necesidad de reeducación espacial digital. Grupo

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con colgajo en isla mediopalmar radial: índice de satisfacción 92%, test de discriminación de 2 puntos 6 mm, puntaje QuickDASH 8, tiempo quirúrgico 60 min; 4 pacientes requirieron reeducación espacial digital. **Conclusión:** Los colgajos dorsolateral y en isla mediopalmar radial resultaron eficaces en el tratamiento de lesiones traumáticas distales del pulgar, aunque el colgajo dorsolateral tuvo mejores puntajes de evaluación objetiva y requirió menos tiempo quirúrgico.

**Palabras clave:** Lesiones distales pulgar; colgajo dorsolateral; colgajo mediopalmar radial.

**Nivel de Evidencia:** III

## INTRODUCTION

A traumatic finger lesion with soft tissue, bone or combined distal defects is a prevalent presentation that is associated with occupational accidents and takes on profound importance when the thumb is injured.<sup>1-3</sup>

We consider the thumb tip to be the segment distal to the interphalangeal joint, which is composed by the distal phalanx, insertions of the flexor and extensor pollicis longus tendons, the pulp and nail apparatus.<sup>4</sup> An average adult thumb tip is 3-4 cm long and 1.5-2.5 cm wide, thus enabling a <4 mm-two-point discrimination and an architecture capable of withstanding substantial pressure.<sup>5-7</sup>

Multiple surgical options have been described for these lesions, all of which prioritize avoiding bone shortening, and achieving tactile and aesthetic restitution. In the daily practice, it cannot be underestimated the role of vascular or neurovascular, with antegrade or retrograde vascular perfusion, innervated or non-innervated flaps.<sup>8,9</sup>

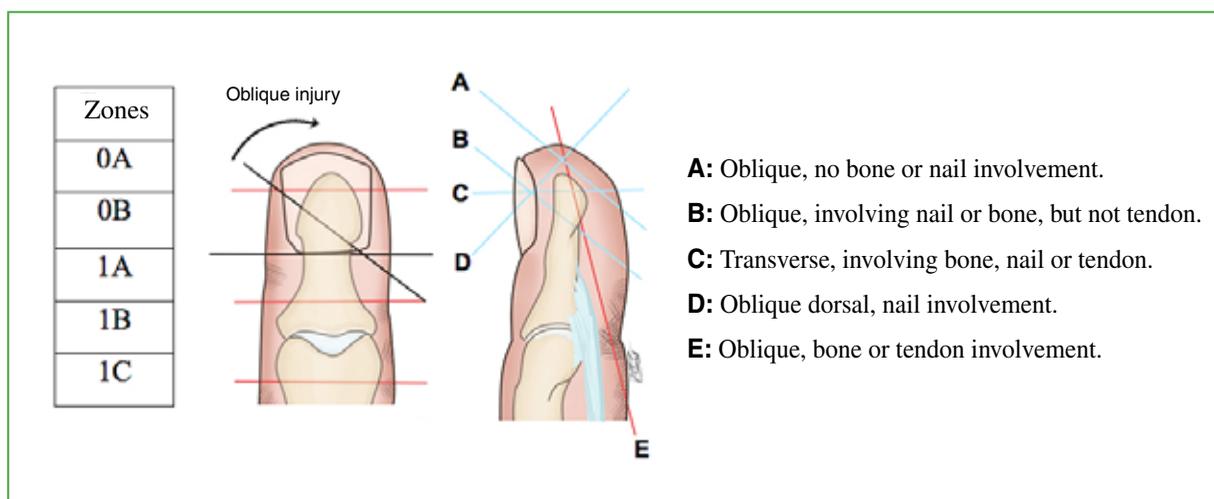
The purpose of the study was to clinically evaluate and compare patients with combined distal thumb lesions treated by a dorsolateral flap or radial midpalmar island flap.

## MATERIALS AND METHODS

We conducted a retrospective study comparing 20 patients with combined distal thumb traumatic lesions.

Thumb lesions were categorized according to the unified alphanumeric classification proposed by Tang *et al.* (Figure 1), which considers the injury mechanism (clean-cut or crush injury), injury obliquity (oblique or transverse), and the involved structures (pulp, nail, bone, and tendon insertion).

Study inclusion criteria included patients with 0A injuries (distal phalanx involvement with intact nail matrix and flexor tendon), no surgical history, who were treated between January 2010 and January 2016 and had at least a 24-month follow-up. Patients who did not meet these criteria were excluded.



**Figure 1.** Tang *et al.* digital tip injury classification. The digital zone divisions are shown on the left. Zone 0 includes the tip distal to the flexor pollicis longus tendon insertion, and is subdivided into zone 0A (nail root intact), and 0B (nail root absent). The zones 1A, B, and C are based on existing flexor tendon zoning. The classification of digital tip injury by structures involved and obliquity is shown on the right.

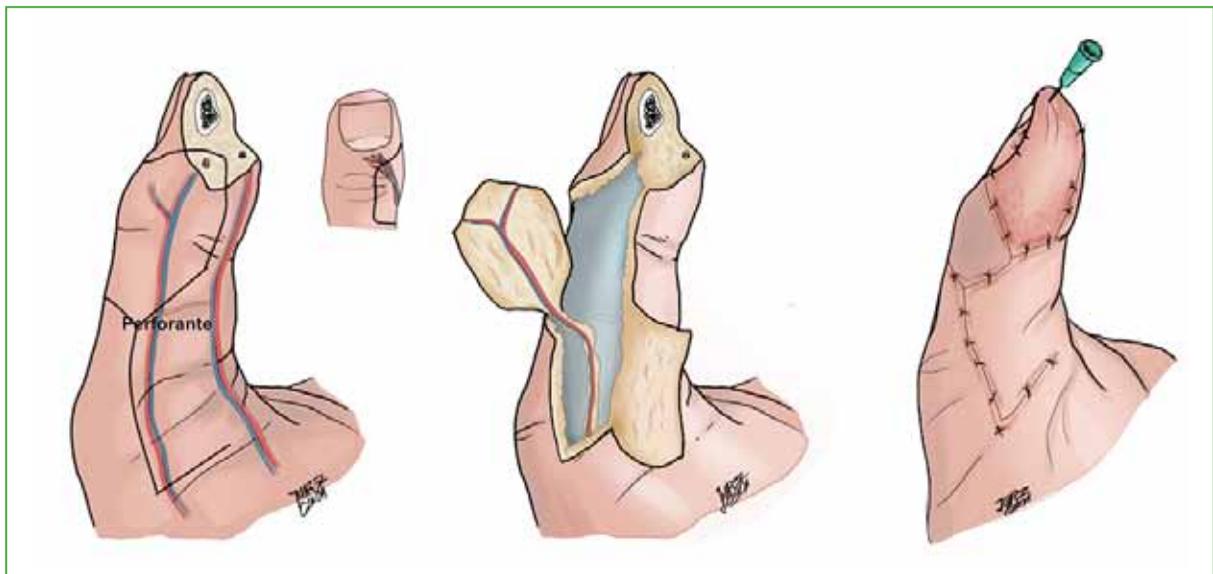
The series consisted of 14 males and 6 females, with a mean age of 35 years (range, 25-45). Sixteen patients (80%) had their dominant hands injured.

All patients had suffered occupational accidents. The study population consisted of two even-sized groups that underwent different surgical approaches, performed by different surgeons at different centers: 10 patients were operated on by MJP using the dorsolateral flap technique, and 10 patients were operated on by CRZ using the radial midpalmar island flap technique. The surgical techniques are detailed below.

### Joshi and Pho's dorsolateral flap surgical technique

Mild sedation nerve block, plexus or general, and block anesthesia is administered, a pneumatic tourniquet with light pressure is applied, and anatomical landmarks are traced (neurovascular bundle surrounding the island flap). A volar-distal approach of the thumb is performed, reaching the palmar crease where it ends in a horizontal "V". Under 3.5 magnification and thorough hemostasis, the radial neurovascular bundle of the thumb is then identified, dissected and repaired. An island flap from the dorsolateral donor site near the distal defect is trimmed, corresponding to the size of the lesion to be resurfaced. The island flap its bundle are then freed from the surrounding tissue and raised as far as the distal palmar crease of the thumb. The tourniquet is then released, adequate hemostasis is confirmed, and flap perfusion is checked by irrigation with warm saline solution. The island flap is then advanced and, using 4-0 monofilament approximation sutures, transposed to cover the receptor area and the previous longitudinal incision, securing a tension-free closure (Figure 2).

Finally, the donor area is covered with free skin graft of the wrist or elbow inner aspect (primary healing). Elastic compressive bandage is applied and then thumb spica plaster splint immobilization is applied.

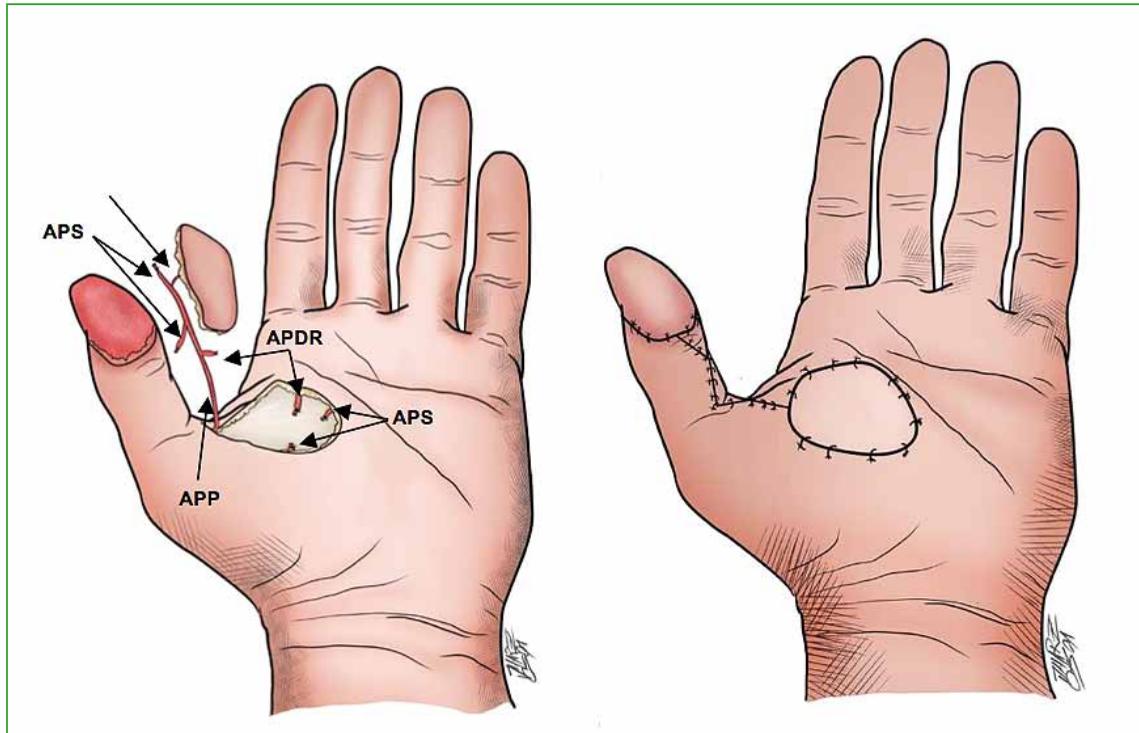


**Figure 2.** Joshi and Pho's dorsolateral flap surgical technique steps.

### Kim's radial midpalmar island flap surgical technique

Plexus or general anesthesia is administered, a pneumatic tourniquet with light pressure is applied, and anatomical landmarks are traced. Flap donor site is determined (according to receptor defect area) around the intersection of the longitudinal line along the radial border of the second metacarpal bone and the transverse line along the proximal border of the thumb. After identifying donor-site skin perforator arteries under 3.5 magnification (2 arteries in average), branches of the superficial palmar arch, the princeps pollicis artery or the radial palmar digital artery of the index finger, their ligation and section are performed, preserving the princeps pollicis artery. A volar Bruner incision is made, with an extended thumb, up to the distal lesion and then super-

ficial to the first lumbricalis and adductor pollicis fascia. Dissection of the princeps pollicis artery is performed maintaining subcutaneous tissue around the vascular pedicle to avoid venous congestion and preserve the thumb pulleys, ligating the collateral branches to allow for a free range of flap transposition without pedicle compression. The tourniquet is then released, adequate hemostasis is confirmed, and flap perfusion is checked by irrigation with warm saline solution. The retrograde-flow island flap is then advanced and, using 4-0 monofilament approximation sutures, transposed to cover the receptor area and the previous longitudinal incision, securing a tension-free closure. Skin-grafting and dressing procedures are similar to those performed after the dorsolateral flap technique (Figure 3).



**Figure 3.** Kim's radial midpalmar island flap surgical technique steps. Flap elevation, on the left side; wound closure, on the right side. This flap can be based on perforators from the terminal branch of the superficial palmar arch (SPA), the princeps pollicis artery (PPA), and/or the radial palmar digital artery of the index finger (RPDA).

## POSTOPERATIVE FOLLOW-UP

Four wound dressing changes per day were performed the first 5 days after surgery in order to check flap perfusion, thereafter weekly wound dressing changes were performed until suture removal. Elastic compression bandage was applied in all patients from day 1. AP and strict lateral X-rays were taken of the injured thumb and of the contralateral thumb (to compare and assess the distal phalanx involvement) at admission and at late postoperative follow-up (to assess for new exostoses that may result in discomfort or esthetic issues).

The subjective outcome was evaluated by the Patient Satisfaction Questionnaire Short Form (PSQ-18), the pain VAS, and the QuickDASH score. The objective outcome was evaluated by the TPDT, the average ST (from the initial skin incision up to the end of the surgical closure, controlled by a surgical auxiliary), and the need for DSR (by occupational therapy).

## RESULTS

Twenty patients were treated. Time from admission to medical discharge averaged 7 weeks (range, 6-8 weeks). All patients healed completely and the average postoperative pain VAS was 01/10.

The dorsolateral flap group averaged a 97% SI, a 2.5 postoperative QuickDASH score, a 4 mm TPDT, a 45-minute ST, and did not require DSR (Figures 4-6). Table 1 shows the dorsolateral flap group data.



**Figure 4.** Preoperative images. Patient with a distal thumb injury.



**Figure 5.** Joshi's dorsolateral flap in the early postoperative period.



Figure 6. Joshi's dorsolateral flap in the distant postoperative period (6 weeks).

Table 1. Dorsolateral flap group results

Patient	SI (%)	VAS	QuickDASH (postoperative)	TPDT (mm)	ST (min)	DSR
1	98	1/10	2.5	4	43	No
2	98	0/10	2	3	40	No
3	95	2/10	3.4	5	55	No
4	96	1/10	2.3	4	40	No
5	95	2/10	3.5	6	50	No
6	97	1/10	2.5	4	40	No
7	99	0/10	2	3	45	No
8	97	1/10	2	4	40	No
9	98	1/10	2.6	4	45	No
10	97	1/10	2.8	4	55	No
Total	97	1/10	2.5	4	45	

DSR = digital spatial reeducation; SI = satisfaction index; ST = surgical time; TPDT = two-point discrimination test; VAS = visual analogue scale.

The radial midpalmar island flap group averaged a 92% SI, an 8 postoperative QuickDASH score, a 6 mm TPDT, a 60-minute ST, and 4 required DSR (Figure 7). Table 2 shows the dorsolateral flap group data.

There were 3 cases of partial dehiscence within the whole study population, with secondary healing, which did not require reoperation.

## DISCUSSION

The reconstruction of combined distal thumb lesions is a common procedure, and many alternatives have been published addressing which technique should be used. The selected technique of defect reconstruction depends on three factors: the size of the defect, the involved structures and the final aesthetic outcome.<sup>4,6</sup>

If the defect is more than 50% of the thumb tip size, reconstruction with flap (either intrinsic or extrinsic to the hand, either innervated or non-innervated) is indicated. Intrinsic flaps offer the advantages of being closer to the lesion, and requiring less dissection time and microsurgical procedure, while flaps innervated beforehand achieve better sensory results and do not require DSR.<sup>4,6,7</sup>



**Figure 7.** Kim's radial midpalmar island flap. **A.** Intraoperative. **B.** Immediate postoperative period. **C.** Late postoperative period.

**Table 2.** Dorsolateral flap group results

Patient	SI (%)	VAS	QuickDASH (postoperative)	TPDT (mm)	ST (min)	DSR
1	88	1/10	10	8	65	Yes
2	94	0/10	6	5	60	No
3	92	2/10	8	8	71	No
4	90	1/10	8	6	56	Yes
5	93	2/10	8	7	50	No
6	89	1/10	10	5	52	Yes
7	93	0/10	8	4	60	No
8	91	1/10	9	6	65	Yes
9	95	1/10	7	6	62	No
10	94	1/10	6	5	64	No
Total	92	1/10	8	6	60	

DSR = digital spatial reeducation; SI = satisfaction index; ST = surgical time; TPDT = two-point discrimination test; VAS = visual analogue scale.

Multiple options have been described to treat these conditions. Among the simplest techniques, the advancement flaps described by Atasoy (volar V-shaped flap) and by Kutler (bilateral V-shaped flap) should be mentioned. They are usually indicated for transverse, distal lesions, and do not require microsurgery, although limited to a maximum axial flap advancement of 1 cm.<sup>10,11</sup>

A more complex technique is the volar neurovascular advancement flap, described by Moberg *et al.*, which advantages include restoring sensation and appearance of the thumb, and has a 1.5 cm axial advancement limit.<sup>7</sup>

Foucher and Braun reported an alternative procedure based on a first dorsal metacarpal artery flap (including the sensory branch of the radial nerve) used to treat thumb medial extension defects.<sup>12</sup>

Moschella and Cordova described a new alternative: a reversed flow pedicled flap from the dorsoradial side of the first metacarpal area, based on the constant anatomy of the dorsoradial collateral artery, branch originating from the radial artery at the anatomical snuffbox level. This flap has a singular extension, having its pivot point at the base level of thumb proximal phalanx and averaging 2-4 cm in length and in width, for this reason is considered an option for radial tip defects.<sup>13</sup>

Brunelli described a reversed flow pedicled flap from the dorsoulnar side of the first metacarpal area, based on the constant anatomy of the dorsoulnar collateral artery. This flap is of similar size to the dorsoradial flap and is suitable for defects of the dorsal and palmar side of the thumb.<sup>14</sup>

Mennen and Wiese published their experience with weekly semi-occlusive dressing changes in fingertip injuries with loss of tissue, and reported a fingerprint restitution time ranging from 6 to 8 weeks, with acceptable aesthetic and sensory outcomes.<sup>15</sup>

First Joshi and later Pho described the neurovascular dorsolateral flap, indicated for palmar and distal digital lesions, which produces acceptable aesthetic and functional restitution, an average flap size of 2-2.5 cm in length and in width, a 4-5 mm-average TPDT, and reduced STs.<sup>1-3</sup>

Kim *et al.* reported acceptable outcomes using their island flap in defects covering more than 50% of the thumb tip size, with flap size ranging from 2 cm to 4 cm in width and from 2.5 cm to 6 cm in length. This flap is suitable for extensive skin defects, although entails slightly longer STs, requires surgical magnification, and has a >5 mm TPDT.<sup>5</sup>

In our study, both techniques proved adequate for the thumb lesion treatment and required no reoperation. The average size of the dorsolateral island flap was 1.5 cm in length and in width, while the radial midpalmar island flap size averaged 2 cm in length and in width. Adequate vascularization was provided by the skin perforators, and there was no record of partial necrosis.

A quite controversial topic among authors, although with numerous reports favoring its theoretical application, is the non-innervated flap reinnervation. In this regard, Dellon and Kallman suggested as the main factor to assess sensory recovery in non-innervated flap cases to be the axonal outgrowth from the receptor site into the flap.<sup>16,17</sup> Hoppenreijns *et al.* reported variable degrees of reinnervation and sensibility associated with pectoralis major myocutaneous flaps.<sup>18</sup> Shindo *et al.* and Meltem Ayhan Oral *et al.* reported that sensory recovery was better in flaps used for smaller defects and suggested spontaneous reinnervation by residual nerve population from the receptor area as a likely cause.<sup>19,20</sup> Finally, Dykes *et al.*, Vriens *et al.*, and Close *et al.*, obtained biopsy specimens from patients who were treated with flap techniques and found significant histochemical evidence of regenerating nerves at the flap margins 3 weeks after surgery.<sup>21-23</sup>

The limitations of this study include: its retrospective nature and a limited study population that was treated by different surgeons, using different surgical techniques. This study strengths were an adequate average follow-up period and having a single person in charge of the evaluation process.

## CONCLUSION

The use of both dorsolateral flap and radial midpalmar island flap in the treatment of traumatic distal thumb injuries proved to be effective. In this comparative series, the dorsolateral flap technique produced better results in terms of objective evaluation and required less ST.

Conflict of interests: Authors claim they do not have any conflict of interests.

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