

Predictors of Proximal Interphalangeal Joint Flexion Contracture After Homodigital Island Flap

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Purpose To identify independent predictors of postoperative proximal interphalangeal (PIP) joint contracture after direct-flow homodigital island flap transfer.

Methods Forty-four fingertip amputations in 39 patients treated with oblique triangular flaps were evaluated at a minimum of 1 year after surgery. Five variables were examined: patient age, injured finger, mechanism of injury, flap advancement distance, and time required for wound healing. Univariate and multivariate linear regression analyses were performed to identify the extent to which these variables affected the flexion contracture of the PIP joint.

Results The average reduction in the passive extension angle of the PIP joint was 16° at final follow-up. Univariate analysis indicated significant correlations of PIP joint flexion contracture with age, injured finger, and time for wound healing, but no significant correlation with the distance the flap was advanced. Multivariate analysis indicated that the age and duration of wound healing were independent predictors of the flexion contracture of the PIP joint.

Conclusions Elderly people and cases with delayed wound healing are at risk for postoperative PIP joint contracture after homodigital flap transfer. Intervention with early hand therapy and orthotics may be useful in elderly patients with delayed wound healing. (*J Hand Surg Am.* 2015;40(11):2155–2159. Copyright © 2015 by the American Society for Surgery of the Hand. All rights reserved.)

Type of study/level of evidence Prognostic II.

Key words Homodigital island flap, advancement flap, flexion contracture, proximal interphalangeal joint, predictor.

HOMODIGITAL ISLAND FLAP TRANSFER is useful in fingertip reconstruction.¹ This flap can also be used as a vascularized bed for the graft-on flap method.^{2,3} Advantages of the homodigital island flap include stable and sensate wound coverage and relatively simple flap elevation. Kojima et al⁴ and Matsui et al⁵ found empirically that the flap can be

advanced to a maximum of approximately 15 mm by releasing the neurovascular pedicle proximally to the proximal phalangeal level. Potential disadvantages of the flap include sensory disturbance of the fingertip when the flap is advanced more than 12 mm and a flexion contracture of the proximal interphalangeal (PIP) joint.^{6,7} The purpose of this prospective cohort study was to identify the determinants of postoperative PIP joint contracture after direct-flow homodigital island flap transfer with a minimum follow-up of 1 year. A better understanding of risk factors might help with prevention of PIP joint flexion contracture after direct-flow homodigital island flap transfer.

MATERIALS AND METHODS

Between 2006 and 2013, 90 patients with a fingertip amputation at Tamai zone 1 (fingertip to the base of

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the nail) or zone 2 (base of the nail to the distal interphalangeal joint) were treated at our institution. Of these patients, 31 underwent digital replantation, composite graft, or revision amputation. The indications for flap surgery were major skin and soft tissue defects of the finger pulp with exposed tendon or bone. Amputations with expected nail growth and regeneration were also good candidates for flap surgery. Twenty patients with a total pulp defect underwent retrograde-flow digital artery flap transfer. A total of 39 patients (44 fingertip amputations) treated with a direct-flow homodigital island flap were enrolled in this study. All 39 patients were informed of the planned treatment and the 1-year follow-up before giving consent (Table 1).

Elevation and advancement of the flap was conducted using the technique originally described by Venkataswami and Subramanian¹ (Fig. 1). The procedure was performed under regional or general anesthesia and 2.5X surgical loupe magnification. A midlateral incision was made from the finger web to the outlined flap. The neurovascular bundle was dissected free of the surrounding tissue in a circumferential fashion from the distal to the proximal incision up to the finger web. This release prevented the pedicle from potential tethering by structures, including Clelands and Graysons ligaments. The flap was inset to cover the fingertip defect and sutured to the surrounding skin using 5-0 chromic suture. In addition to the mobilization gained by complete dissection of the neurovascular bundle, interphalangeal joint flexion of 10° to 20° facilitated advancement of the flap into the defect.

The average length of the flap was 12 mm (range, 7–15 mm). All operations were performed by 1 surgeon in a similar fashion. For 12 fingers, the graft-on flap method was used. In this technique, the nail matrix, perionychium, hyponychium, and bone fragment were harvested from the amputated part as a composite graft. Once the homodigital island flap was advanced to replace the finger pulp, this composite graft was then inset directly on the raw surface of the flap. This allowed for preservation of delicate nail complex structures in cases where most of the nail was amputated. For 32 fingers, only the homodigital island flap was used.

On removal of the bulky dressing 4 days after surgery, we applied a dressing, then monitored wound healing 2 or 3 times each week, and recorded the time required for complete healing of the wound. We began active assisted motion at 2 weeks and passive motion at 4 weeks after surgery. At 1 year and at final follow-up (average, 33 months; range, 12–84 months), we assessed for flexion contracture of the PIP joint. The

TABLE 1. Summary of Patients

Patient characteristics	Age (y)	43 ± 17 (16–71)*
	Sex	Male: 32
		Female: 7
Injury characteristics	Injured digit	Index: 14
		Middle: 18
		Ring: 10
	Mechanism	Little: 2
		Clean-cut: 15
		Crushing: 17
Surgical characteristics	Avulsed: 12	
	Flap advancement distance (mm)	12.2 ± 2.7 (7–15)*
	Wound healing period (d)	19 ± 9 (8–41)*
	Surgical Procedure	Simple advancement method: 32
		Graft-on flap method: 12
Follow-up period (mo)	20 ± 15 (12–84)*	

*Average ± SD (range).

degree of flexion contracture was defined as the reduction in the passive extension angle at the PIP joint, as measured using a standard goniometer.

The study was approved by the hospital institutional review board and informed consent was obtained from all patients.

Statistical analyses

Five independent variables were examined: age, injured finger, mechanism of injury, flap advancement distance, and time for complete wound healing. The dependent variable was the degree of flexion contracture of the PIP joint of the affected digit at final follow-up. These variables were included in univariate and multivariate linear regression analyses to determine factors associated with postoperative PIP joint flexion contracture. A backward stepwise procedure was used to test all predictor variables with $P < .05$ in univariate analysis as candidates in final models. An adjusted R^2 value was obtained to reflect the percentage overall variability for each variable in the multiple linear regression model. A sample size calculation (anticipated effect size, 0.73) was performed with a resulting sample size of 37.

RESULTS

All flaps survived completely, and there were no complications such as infection, cold intolerance, or

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