

# EIGHT YEARS EXPERIENCE IN CRUSH AND AVULSION TYPE FINGER AMPUTATION

FUAT ÖZERKAN, M.D., SAİT ADA, M.D.,  
ARSLAN BORA, M.D., İBRAHİM KAPLAN, M.D., and  
YALÇIN ADEMOĞLU, M.D.

Between July 1986 and July 1994, we studied 125 total finger amputations due to crush and avulsion type injuries at the İzmir Hand and Microsurgery Hospital. Of the 125 fingers replanted, 88 were successful, for a general survival rate of 70.4%. In the period between 1986 and 1991, we performed end-to-end anastomoses and achieved a survival rate of 48.3% (Group I). Between 1991 and 1994, with the application of a primary interpositional vein graft for the required

indications in this type of injury, the general survival rate increased to 77.1% (Group II;  $P < 0.05$ ). We conclude that the significant increase in the survival rate in Group II is related to both the increased experience of the surgical team and the application of the primary interpositional vein graft.

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**G**enerally, in crush and avulsion type injuries of the fingers, there is a gap between the vessel ends. Excessive shortening,<sup>1</sup> microvein and artery grafts,<sup>2,4-6,9</sup> vascular pedicle transfer,<sup>3</sup> and reconstructive procedures are the methods used to solve this problem in salvaging the fingers.

The aim of this study was to determine the general survival rate in crush and avulsion type total finger amputations, and to allow our surgical team the opportunity to compare the survival rate of the two replantation groups for the amputations that originated from the same type of injury. Also, the study demonstrated the improving performance of our surgical team at the Replantation Center.

## MATERIALS AND METHODS

Between July 1986 and January 1991, 29 fingers were replanted using end-to-end anastomoses with a great amount of shortening (Group I).<sup>1</sup> Between January 1991 and July 1994, for the 96 fingers replanted, primary interpositional vein grafts were applied routinely for the required indications (Group II).

When attempting to classify the type of injuries as crush or avulsion, the mechanism causing the injury and the condition of the amputated part was taken into consideration. In situations where crush and avulsion both occurred, the most serious injury was used to determine the classification.

In the interpositional vein graft applications, in order to select a healthy vessel end for the anastomosis, the red

ecchymotic zones on the vessel were passed over, the endothelials of the vessel were revised, and at least one healthy branch of the vessel was passed over toward the proximal or distal end. The graft was covered completely with healthy skin. The levels of finger amputations were studied according to their zones (Table 1).

In the study, the length of the interpositional vein grafts varies from 0.5 cm. to 5.0 cm. All of the replantations were performed by the same surgery team. The donor site in all of the cases was the vein on the volar forearm. Technically, the proximal anastomosis was carried out preceding the distal anastomosis without allowing kinking or longitudinal rotation. For examples from our study see Figures 1 through 5.

Of the 93 patients, 83 were male and 10 female. The youngest patient was 1 year of age and the oldest was 59 years of age, with the average age being 25.8 years.

In the postoperative follow-up, the patients were given 500 cc/day of low molecular dextran, 5,000 units  $\times$  2 sc. of heparin sodium, 500 mg/day of acetyl salicylic acid, and 5 mg/kg of gentamycin sulphate for one week. The fingers were followed up in the hospital by clinical observation for 6-16 days, without and with monitoring. For the replantations in Group II, reoperation was performed without hesitation in any case of suspicion about the circulation of the finger.

## RESULTS

Between 1986 and 1991, all of the fingers were replanted using end-to-end anastomoses with a high amount of shortening (Group I). The survival rate was 48.3%, or 14 out of 29 fingers. Between 1991 and 1994, primary vein grafts were applied routinely for the required indications in the same type amputations (Group II). The survival rate was

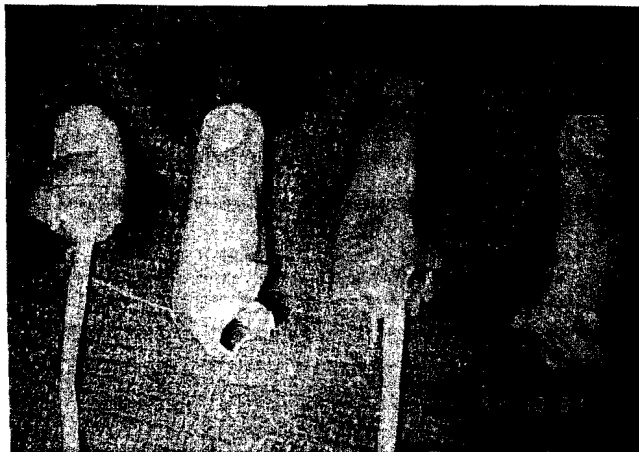
From the Hand and Microsurgery Hospital, Kahramanlar-Izmir/Turkey.

Address reprint requests to Sait Ada, M.D., El ve Mikrocerrahi Hastanesi, 1418 Sokak, No: 14, 35230 Kahramanlar-Izmir/Turkey.

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**Table 1.** Levels of Finger Amputation.

Zone	
I	Lunula distal
II	Between lunula and DIP joint
III	Between DIP and insertion of FDS
IV	FDS insertion and MP joint just distal
V	MP joint level

*Figure 1.* Avulsion type amputation of thumb, index, middle and ring finger.

77.1% or 74 out of 96 fingers. A general survival rate of 70.4% was achieved (Table 2).

Although the survival rates were significantly different in the cases using end-to-end anastomoses between Groups I and II (Table 3), the rates were not significantly different when comparing end-to-end anastomoses and interpositional vein grafts within Group II (Table 4).

Primary interpositional vein grafts were not applied in zone I, but they were frequently applied in zones II, III and IV. The increase in the survival rate toward the proximal end is more obvious in avulsion type injuries. Reoperation was performed in 6 of the 37 cases with primary vein grafts, for a reoperation rate of 16.2%. In all of the reoperated fingers, interpositional vein grafts were replaced by longer grafts allowing for more excision of the damaged vessel on both the proximal and distal ends. Three of these 6 fingers eventually survived (Table 5).

Of the 21 interpositional vein grafts which were applied in crush type amputations, 13 were only applied on the artery, 4 were only applied on the vein, and 4 were applied on both the artery and the vein. In the avulsion type amputations, 4 of the grafts were only applied on the artery, 4 were only on the vein, and 8 were applied on both the artery and the vein. This series shows the tendency to apply microvein grafts to the artery in crush type amputations and to both the artery and vein in avulsion type amputations.

*Figure 2.* Application of microvein graft.*Figure 3.* Soon after replantation of thumb, index, and ring finger.

## DISCUSSION

Interpositional vein graft applications, their lengths, diameter discrepancies, and the hemodynamic factors involved in double anastomoses have been examined with experimental studies. Fujikama and O'Brien<sup>7</sup> have stated that in their experimental studies, there was no patency difference in vein grafts that were no longer than 40 mm. Boris et al.<sup>8</sup> have stated that the rate of patency in vein grafts of 2 to 10 cm was 80–83%. Bunckee<sup>9</sup> has determined that there is no difference between the patency of the microvascular anastomosis and the vein graft. Zhang and Oliva<sup>10</sup> have determined no difference between the application of the graft in artery or vein in terms of patency in interpositional vein grafts of 10 mm in length. Büchler and Bunckee<sup>11</sup> have determined the optimal ratio of graft to recipient vessel diameter to be 1/1 and 1/1.5.

Hamilton<sup>4</sup> achieved a survival rate of 27% with end-to-end anastomoses used in avulsion type amputations and a



Figure 4. Pinch function between the replanted thumb and index finger after 10 months.



Figure 5. Opposition function of the replanted thumb after 10 months.

survival rate of 57% with the application of interpositional vein grafts in avulsion type amputations. Vlastou and Earle<sup>5</sup> demonstrated a 100% survival rate using interpositional vein grafts in avulsion type amputations. However, Urbaniak<sup>6</sup> has stated that the application of interpositional vein grafts was about 20% in his series and that, especially for thumb avulsions, it was easier and more dependable compared to arterial pedicle transfers. Tark and Kim<sup>2</sup> achieved a survival rate of 72.0% with 32 crush and avulsion type total finger amputations.

In our hospital, between 1986 and 1994, a total of 125 crush and avulsion type finger amputations were replanted. Eighty-eight were successful, a survival rate of 70.4%. We found in our study that survival rate differences between Group I, in which we utilized shortening and end-to-end anastomoses (48.3%), and Group II, in which we applied

**Table 2.** The Survival Rate of the 125 Crush and Avulsion Type Total Finger Amputations.

Group		%
I	14/29	48.3
II	74/96	77.1
Total	88/125	70.4

**Table 3.** The Survival Rate of the Crush and Avulsion Type Total Finger Replantations Using End-to-End Anastomoses in Group I (Between 1986 and 1991) and in Group II (Between 1991 and 1994).

Group		%
I	14/29	48.3
II	44/59	74.5

**Table 4.** The Survival Rate of the 96 Crush and Avulsion Type Total Finger Replantations Applied in Group II (Between 1991 and 1994).

End-to-End anastomose	44/59	74.5%
Interpositional vein graft	30/37	81.1%
Total survival rate	74/96	77.1%

**Table 5.** Applications of Primary Interpositional Vein Grafts According to Their Zones.

Zone	Number of fingers	Survival	Failed	Survival rate (%)
I	—	—	—	—
II	10	6 (1 <sup>a</sup> )	4 (2 <sup>a</sup> )	—
III	9	9	—	—
IV	15	12 (1 <sup>a</sup> )	3 (1 <sup>a</sup> )	—
V	3	3 (1 <sup>a</sup> )	—	—
Total	37	30 (3 <sup>a</sup> )	7 (3 <sup>a</sup> )	81.1

<sup>a</sup>Fingers that received second interpositional vein grafts at reoperation.

interpositional vein grafts (77.1%), were statistically significant ( $P < 0.05$ ). However, we cannot attribute the overall survival increases only to the use of the primary vein graft since we don't find any significantly different survival rates in Group II between end-to-end anastomoses and interpositional vein grafts. We speculate that this difference also relates to the increasing experience and improving ability of the surgical team.

## CONCLUSION

Many factors, such as experience and knowledge, play a role in improving the survival rate in replantation surgery. Our surgical team has been working together since 1986. We still have problems to overcome in dealing with crush and avulsion type amputations, as do the other surgical teams performing replantation surgery. Interpositional vein grafting is a valuable technique that is accepted in this type of replantation. In clinical applications, however, it is dif-

ficult to understand the positive effect of the interpositional vein graft on the resulting survival.

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