Basrah Journal Of Surgery

Original Article
Bas J Surg, March, 13, 2007

A COMPARATIVE STUDY OF THE SUPRAPERIOSTEAL AND THE SUBPERIOSTEAL DISSECTION IN THE V-Y ADVANCEMENT (ATASOY) FLAP FOR THE MANAGEMENT OF FINGERTIP INJURY

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Abstract
The classical Atasoy depends on the cutting of the fibrous bands of the digital pulp in order to gain advancement of the flap to cover the fingertip injury defect. A new modification of Atasoy flap was studied in comparison to the classical Atasoy flap. Thirteen patients included in this study at Al Wasity hospital between September 2003 to April 2005 they were complaining of class III Allen's fingertip injury of different fingers,3 females and 10 males , 4 cutting and 9 crushing type injury. Seven patients underwent reconstruction by the new modified Atasoy flap and 6 patients by the classical Atasoy flap. The results show that the new modification of Atasoy flap is more fitted with the principles of pulp surgery. It improves flap viability, sensibility and aesthetic results reduce the troublesome hypersensitivity and produce more physiological cover to the bone. These results may be attributed to preservation of the fibrous septae of the pulp space and avoiding the injury of the vessels and nerves by passing subperiosteall in the flap dissection.

Introduction
The fingertip is that anatomical part beyond the distal interphalangeal joint. It contains the distal phalanx, the perionychium (nail plate, nail fold, nail bed and paronychium) and pulp[1]. The dorsal surface of the fingertip comprises the nail fold, nail bed, nail plate and paronychium (=perionychium). The paronychium is the skin surrounding the nail plate radially and ulnary. The eponychium is the epidermal shelf at the base of the nail. The lunula is the white semicircle at the base of the nail bed; the nail fold and lunula germinate 90% of the nail. The hyponychium is the keratinaceous plug beneath the nail at the junction of the nail bed and the pulp contains high concentration of WBC and acts as barrier for infection. The fingernail like hair is considered as epidermal appendage[2]. The volar skin surface of the fingertip contains grooves and ridges, uniquely patterned for each individual, termed fingerprint.

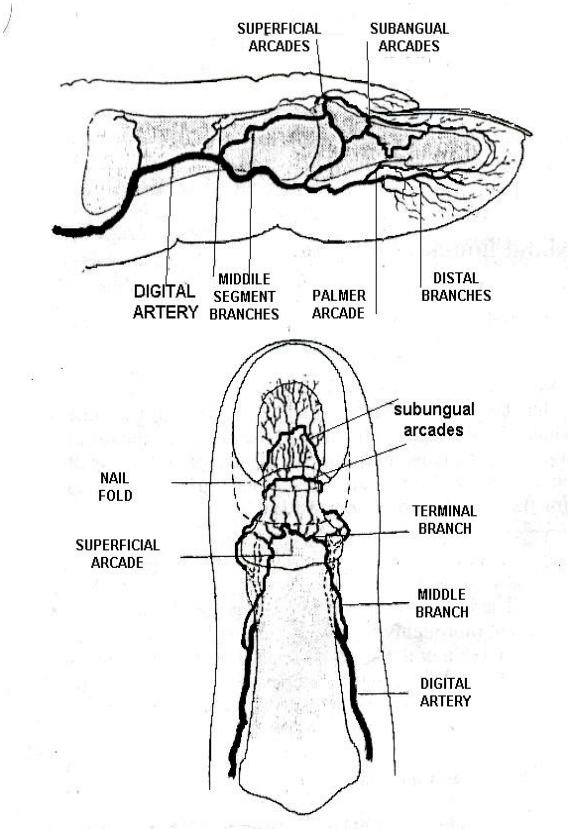
The skin is abundantly supplied with sensory receptors, including Pacinian and Meissner corpuscles and Merkel cell neurite complexes. The tactile receptor sensitivity of the fingertip is further enhanced by the counter pressure provided by the tip of the phalanx and the rigid dorsal nail[1]. Sweat glands in the skin keep the surface just moist enough to enhance the gripping properties of the skin[1].

The fibrous bands that anchored the skin to the distal phalanx appeared not as compartments within the pulp space but as a number of well-organized collagen fibers to hold it in place, much as a

parachutist is attached to a parachute[3]. Thus prevent gliding of the overlying skin and provide nonslip gripping surface[1]. The volar pulp is also stabilized by Grayson and Cleland ligaments that extend from the flexor sheath and distal phalanx volar and dorsal to the neurovascular bundles, respectively[2]. The fibrous septae take a conical shape entrapping in it fatty tissue rich in blood vessels and lymphatic.

The digital arteries trifurcate near the distal interphalangeal joint. The proper digital artery crosses the distal interphalangeal joint, sending a branch to the nail fold, nail bed, pulp forming the superficial and subungual arcades[4] and a distinct digital pulp arch over the mid-point of the terminal phalanx in 93% of digits[5]. There are numerous branches that arise from the pulp arch to the tip of each digit[5] (figure 1).

Figure 1: The blood supply of the finger tip



Fingertip injuries are one of the commonest referrals to casualty department. Injuries to the fingertip are about 45% of hand injuries[1]. It is a very important type of injury because of its direct impact on work; some times they lead to changing of work or end of career[1].

A particularly useful classification for fingertip injury was proposed by Allen[6], it separates amputation injuries into four types based on the type of amputation, i.e. through the tissue involved.

Type I injuries; involve only the skin and the pulp of the distal digit.

Type II injuries; involve the pulp and nail bed.

Type III injuries; with loss of part of the terminal phalanx.

Type IV injuries; are amputation proximal to the lunula.

These injuries can be either transverse or oblique, the obliquity of the injury can be along the dorso-ventral axis or along the radio-ulnar axis, so if more tissue is lost from the volar than the dorsal side it is called dorsal oblique injury while if the loss is more on the dorsal than the volar it is called volar oblique.

The ulnar or radial oblique amputations also classified into levels from (1-5) according to the amount of tissue loss.

Though frequently termed Atasoy flap, Tranquilli-Leali first described the volar V-Y flap in 1935, while Atasoy describe it in 1970[2]. Atasoy V-Y advancement flap was originally based on incising the skin in V-shape and undermining it at subcutaneous plane dividing the fibrous septa and by gentle perpendicular blunt subcutaneous dissection on the sides of the flap it can be mobilized to cover the exposed tip of the finger. The flap should be as wide as the nail bed and not extended beyond the DIP Joint.[1, 2, 6-13].

The aim of the present study is to introduce a new modification on Atasoy flap to improve the viability, sensation and produce better aesthetic results.

Patients, materials & methods

Thirteen patients with fingertip injuries were included in the study in Al–Wasity hospital between September 2003 to April 2005, 10 of them were males and 3 were females. The patients selected were with fingertip injuries of grade III according to Allen's classification[7] and only those who had transverse or dorsally oblique plane of injury[7]. Patients with grade IV injury and those with volar, radial, ulnar oblique plane of injury were excluded as they are not suitable for Atasoy flap (Table I).

The patients were divided into two groups according to the type of surgery:

Group I: the undermining was through the subperiosteal plane with a V-shape incision in the periosteum

Group II: the undermining of the flap was supraperiosteal

Materials that were used in this study were blade no.15 to cut the skin and periosteum, Gezahut sharp edge dentate scissors for subcutaneous dissection and fibrous septae division, Howarth nasal raspatory(double ended) for subperi-osteal undermining, Gillies skin hooks, Waugh dissecting forceps(one into two teeth),Waugh dissecting forceps (slightly heavier nontooth serrated jaw), bone nibbler and raspitor to smooth the bone end, nylon suture 4/0 and 6/0, xylocain 2% without adrenaline for digital nerve block and rubber band tourniquet .

Surgical procedure: Surgery was performed in the operative theater. Skin preparation and toweling of the injured limb up to the mid forearm with 10% povidone Iodine solution. Digital block was Performed using 2% plain lidocaine (Xylocain) administered on both sides of the proximal finger to achieve adequate anesthesia. Exangeuation and application of tourniquet using a rubber band at the base of the affected digit. The wound was thoroughly cleaned using saline jet. The devitalized tissue was debrided. Bone spikes smoothed out very conservatively using bone nibbler and rasptor to provide smooth and rounded bone end for the advancement of the flap. The flap was designed on the volar aspect of the injured finger in a V-shape (Fig.3 B, Fig.4 B). The tip of the flap is directed toward the flexor crease of the DIPJ and should not cross it. The width of the flap should be equal to the width of the nail bed, after the V-shape skin incision was done undermining of the flap was adopted either through: The supraperiosteal plane (subcutaneous) by the small gezahut scissors, the subperiosteal plane by Howarth periosteal elevator (Fig.4 C) then a V-shaped incision similar to that of the skin was performed in the periosteum by no.15 blade knife by introducing it between the bone and periosteum under direct vision (Fig.3 C, Fig.4 D).

By gentle perpendicular blunt dissection using scissors separating the flap from the adjacent subcutaneous tissue (Fig.4 E). Care is taken not to damage the crossing vessels and nerves, fibrous septa that bridge between the flap and the surrounding tissue should be identified carefully and cut by scissors to allow advancement of the flap (Fig.4 F). The tourniquet was removed and haemostasis secured. The flap was observed for good capillary refill and color. There could be a delay in recovery of blood flow for five to ten minutes.

All patients were asked to move the distal phalanx to ensure that there is no damage to the flexor digitorum profundus tendon.

In group I the skin and periosteum was used to cover the bone end the periosteum is fixed in place by horizontal matrix suture to the paronychium (Fig.4 G).

In group II only the skin was sutured, started by fixing the flap base by suturing it to the nail plate or paronychium then the central limb of the Y is sutured followed by the closure of the remaining skin. Light dressing was applied in the form of cotton gauze

socked in povidone iodine then dry cotton gauze followed by crepe bandage
All patients receive cephalexien (Keflex) capsule 500mg 4 times / day for 7 days.
The patient instructed to keep the arm elevated for 7 days.

In summery the difference between the modified and classical Atasoy occur in that the plane of dissection is subperiosteal with a V- shaped cut in it while the skin and subcutaneous dissection is similar in both.

The follow up program was including regular visits[14]. The first visit at the third post op. day, This visit includes removal of the operative dressing, assessment of the flap viability and the presence of infection. After two weeks, the flap was evaluated for any loss, sensation of the flap is evaluated by the static and mobile two point discrimination. After 6 weeks the patient symptoms declared specifically pain, cold intolerance, hyperesthesia or parasthesia, the scares examined, the patient is allowed to use his finger for normal daily activities. After 12 weeks, the appearance of the fingertip is evaluated whether (rounded or flat), the patients are encouraged to use the finger in heavy work.

Results

In group I, seven patients were included two of them injured their thumbs, two injured their middle finger, two injured their ring fingers and one little finger. While in group II, 6 patients were included three injured their middle fingers, one thumb, one index and one little finger.

About 57.1% of group I sustain cutting injury while the remaining had crushed injury. While in group II only 16.6% had cutting injuries and the remaining was crushing injuries (Table I).

The advancement of the flap in group I have reached the maximum limit of the classical Atasoy (group II) (5-10 mm)[15] and exceed it up to 11 mm in case no.4 while it had remain under that limit in group II. The flap in group I was thicker than in group II. Viability was 100% in group I and 93% in group II (Table II).
The infection rate in group I was 14% and 16.6% in group II.

Pain that interferes with activity and the use of the finger was significantly lower in group I (40%) in comparison to (50%) in group II.

Regarding sensation the two point discrimination (2pd) of the classical flap (group II) was 79% of the control (Tupper J. and Miller G. have got a 73% of control[17]) while the modified flap (group I) have 2pd (90.5% of the control).

The aesthetic results were improved by the ability to produce rounded tip in 71% while in group II it was achieved in 33%.

Discussion

"Principles of treatment for injuries or infections of the digital pulp should attempt to preserve this anatomical construct (fibrous septa) so that the firmness and vascular supply of the fingertip are maintained and not disrupted"[3].
This important principle in pulp surgery that stated by Hauck et al.[3] was violated by the classical Atasoy flap in which large areas of the fibrous septa were dissected while passing through the subcutaneous tissue (group II). Where as our modification by passing sub-periostealy will preserve these fibrous septae leading to the maintenance of the pulp infrastructure with the gain of many advantages as mentioned below.

The viability of the modified flap (group I) was 100% while the viability in group II was 93%. This may be attributed to damage to the vessels that pass through the same plane of dissection (supra-periostealy)[5,16], so passing subperi-ostealy will protect the vascular tree of the pulp and maintain viability.

The advancement of the modified flap (group I) was easy to reach the maximum limit of the classical Atasoy

(5-10mm)[1,15] and exceed that limit to reach up to 11mm in case no. 4 , because of the close proximity of the periosteum to the bone so it's advancement can reach further than the skin, and covered the bone easily.

The thickness of the modified flap is more than that of the classical one not only by the addition of the periosteum but by the addition of the preserved part of the subcutaneous tissue. This thickness and the preservation of the fibrous septae will maintain the firmness of the pulp and provide more rounded and aesthetic pulp.

The infection rate was not significantly different between the two groups so the level of dissection dose not affects the infection rate.

The sensation of the modified flap was superior to the classical flap. The two point discrimination (2pd) of the classical flap was 75% of the control (the opposite finger)[17], while the modified flap has two point discrimination (2pd) of 90% of the control. This may be explained by the fact that in passing subperiostealy the nerves will be protected, besides the preservation of the firmness of the pulp may assist in the improved sensation.

Troublesome hypersensitivity, pain, and cold intolerance were 40% in the modified flap while in the classical flap they were 50 % (60%in (17)) (50% in[2] and that may be due to the reduced damage to the nerves, vessels and the cover of the bone by periosteum.

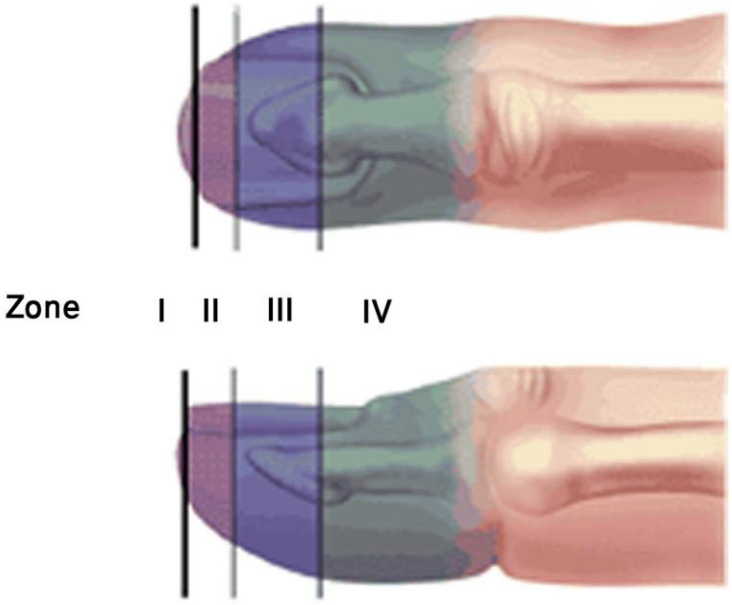
The cover of the bone end by periosteum was more physiological and may contribute to uniform healing of the bone and reduce spur formation which may explain the reduced painful complications.

The aesthetic results were superior in the modified flap (71%) while it is 33% in the classical flap and this is due to better advancement of the modified flap and increased thickness of it plus the presence of the periosteum that gives a good layer for anchoring the flap into place which decrease the chance of migration of the flap proximally.

This new procedure is not a difficult technique and reproducible, and may be much safer and easier to junior and senior surgeons.

In conclusion, the new modification of Atasoy flap goes better with principles of pulp surgery, it improve flap viability and sensibility and give better Aesthetic results, reduced the troublesome hypersensitivity and produce more physiological cover to the bone.

Recommendations; Further extended studies for prolonged period to provide a better evaluation of the results and to include the evaluation of the use of periosteum to cover the bone in regard to spikes formation and bone end shape are needed. Nail growth and nail deformities should be looked for longer periods.



Allen's Classification

Figure 2

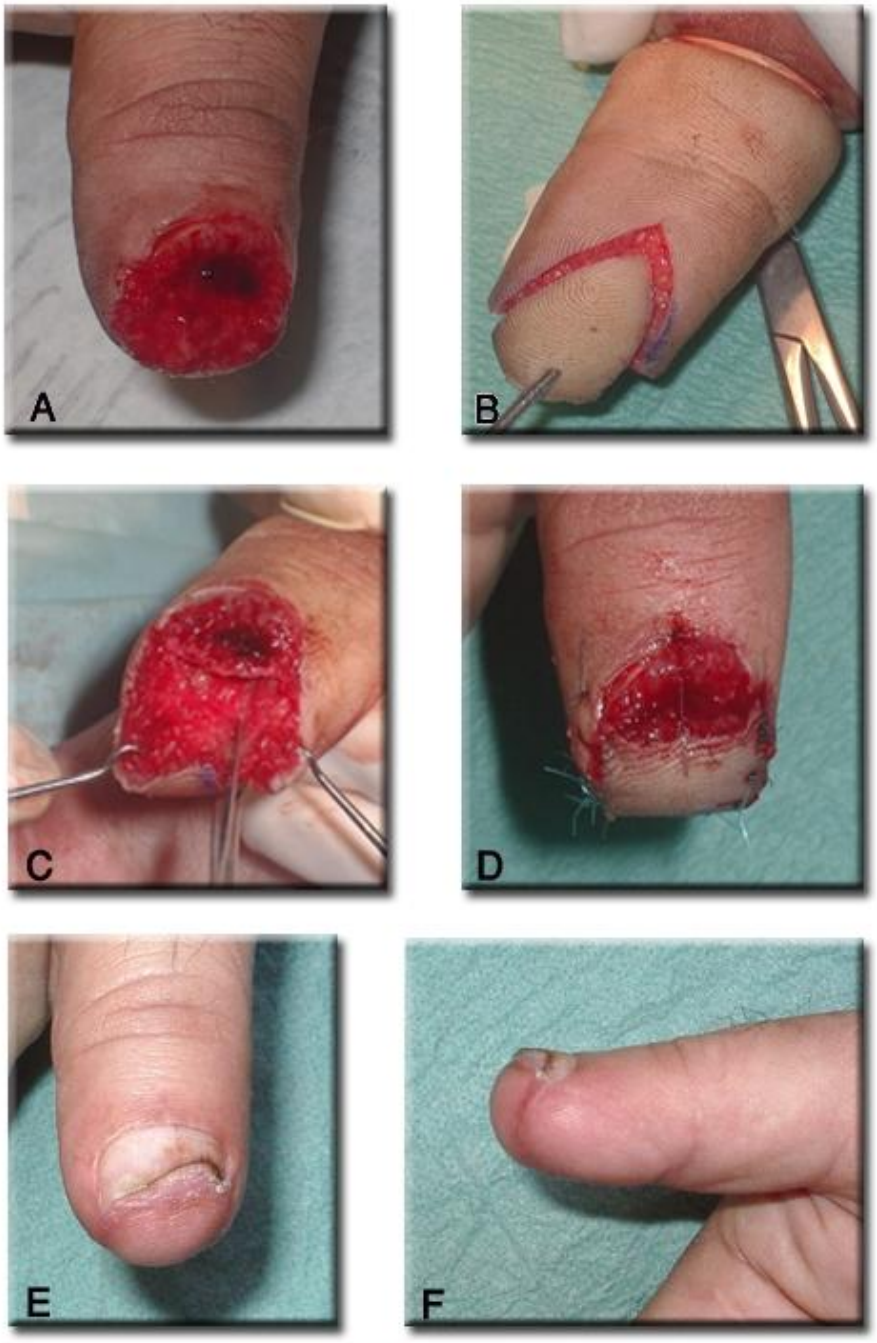


Figure 3 case no. 4 class III, dorsal oblique .injury managed by the modified Atasoy tech

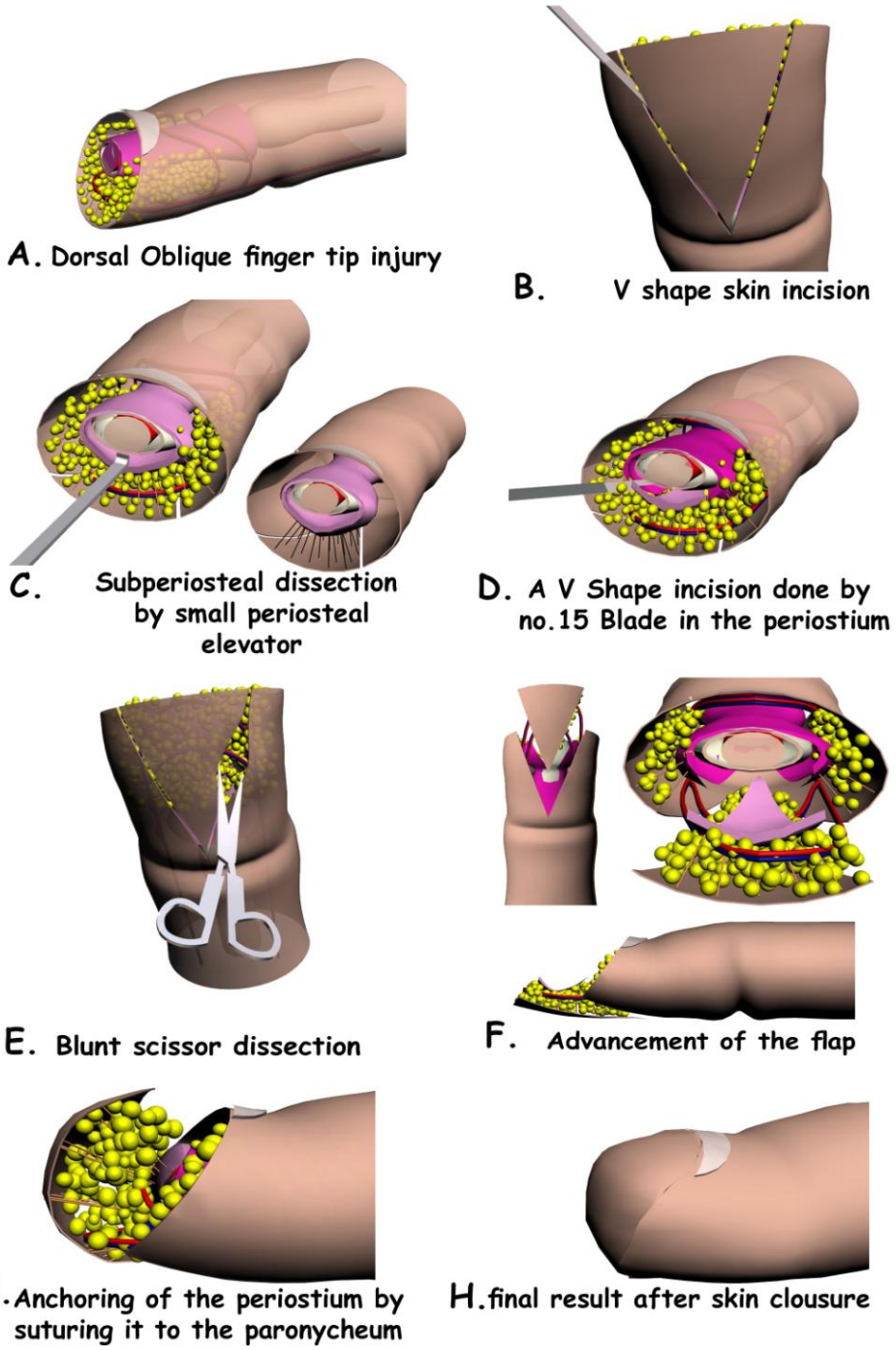


Figure.4 Computer simulation of the surgical procedure of the modified Atasoy flap.

Table I: Number of the patients, age, sex, and the type of injured finger having Allen's class III injuries and the type of injury.
Group I represent the modified Atasoy flap.
Group II indicates the classical Atasoy flap.

	PATIENT'S NO.	AGE	SEX	FINGER	ALLEN'S CLASS	CAUSE
GROUP I	1	23	Female	Ring	III	Crush
	2	19	Male	Middle	III	Cutting
	3	22	Male	Thumb	III	Crush
	4	23	Male	Middle	III	Cutting
	5	42	Male	Thumb	III	Cutting
	6	6	female	Ring	III	Crush
	7	55	Male	Little	III	Crush
GROUP II	8	22	Male	Middle	III	Crush
	9	15	Female	Middle	III	Cutting
	10	37	Male	Ring	III	Crush
	11	52	Male	Thumb	III	Crush
	12	17	Male	Index	III	Crush
	13	22	Male	Middle	III	Crush

Table II: A comparison of the results of the modified Atasoy (group I) and the classical Atasoy (group II).
* 2PD = two point discrimination test

Patients No.		Viability	Infect.	Sensibility Control 2PD Static	Control 2PD mobile	Flap 2PD static	Flap 2PD mobile	Troublesome pain	Aesthetics
GROUP I	1	100%	NO	4	3	4	3	NO	Rounded tip
	2	100%	NO	3	3	3	3	YES	Rounded tip
	3	100%	YES	3	3	3	3	YES	Flat tip
	4	100%	NO	5	4	4	3	NO	Rounded tip
	5	100%	NO	3	3	3	3	NO	Rounded tip
	6	100%	NO	4	3	4	3	YAS	Rounded tip
	7	100%	NO	6	5	5	4	NO	Flat tip
GROUP II	8	100%	NO	3	3	3	3	NO	Flat tip
	9	80%	NO	4	4	3	3	YES	Flat tip
	10	100%	YES	5	4	4	3	YES	Flat tip
	11	100%	NO	4	4	4	4	NO	Rounded tip
	12	80%	NO	4	3	3	3	NO	Rounded tip
	13	100%	NO	5	5	4	3	YES	Flat tip

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