Extensor Digitorum Brevis Free Flap: Anatomic Study and Further Clinical Applications

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The extensor digitorum brevis muscle flap is reliable, safe, and can be used either as a pedicle or as a free flap with minimal donor site morbidity. To increase the existing knowledge of this flap and to establish further anatomic basis for the design and elevation of the extensor digitorum brevis flap, 26 specimens from 13 fresh cadavers were dissected under 3.5× loupes. The lateral tarsal artery was found to be the main blood supply to the muscle. It has an average diameter of 1.83 ± 0.35 mm and a length of 1.89 ± 0.69 cm. The dorsalis pedis artery has, at the level of the lateral tarsal artery takeoff, a diameter of 3.25 ± 0.62 mm. From this point to the origin of the deep plantar branch, the dorsalis pedis artery has minimal branching, and the surgeon has available an artery homogeneous in diameter that is 6.77 ± 0.99 cm in length. Related neurovascular structures (anterior tibial artery and the venae comitantes, dorsalis pedis and first dorsal metatarsal artery, and deep peroneal nerve) were also studied. A safe and reliable harvesting technique and the "T interposed extensor digitorum brevis" technique for sparing the anterior tibial artery are presented, as are clinical case examples on the use of this flap as a flow-through, extensor digitorum brevis-vascularized nerve graft, a combined extensor digitorum brevis-deep peroneal nerve graft, and a bilobed extensor digitorum brevis-dorsalis pedis fasciosubcutaneous free flap. (*Plast. Reconstr. Surg.* 105: 1347, 2000.)

The extensor digitorum brevis muscle has been widely used as an island flap, with antegrade flow to cover defects around the ankle[1–9] and reverse flow for defects on the distal foot,[9–11] and as a free flap to cover small defects[3,7,12] or for functional restoration.[13–16]

The gross anatomy of the muscle is well described in classic anatomy textbooks.[17,18] Landi et al.[1] studied the vascular anatomy of the extensor digitorum brevis in seven cadavers. They found a primary artery (the lateral tarsal artery) and an accessory artery located 1 to 3 cm distal to the main artery. Giordano et al.[4] stated, on the other hand, that "the lateral tarsal artery is the dominant arterial supply of the muscle"; in fact, they advised ligating the dorsalis pedis distal to this branch to preserve the skin blood supply of the dorsum of the foot. Recently, Baltensperger et al.[19] and Bakhach et al.[11] studied the extensor digitorum brevis, focusing, respectively, on the feasibility of the flap for covering the ankle area and on its use as a distally based flap, even in cases when the dorsalis pedis is interrupted.

The purpose of this article is to expand, on the basis of an anatomic study, the applications of the extensor digitorum brevis as a free flap.

Materials and Methods

The anatomic study was performed on 26 feet from 13 fresh cadavers. At time of death, the subjects were 18 to 80 years of age and were apparently free of local or vascular disease. Table I contains the specimen data and morphometric findings regarding the muscle itself. Dissections were performed under clear light conditions and with the help of 3.5× loupes.

The takeoff of the lateral tarsal vessels was identified and its relationship to the inferior edge of the retinaculum and the talocrural joint was recorded. The dorsalis pedis was tracked distally, as was the first dorsal metatarsal. The muscle itself was then dissected en bloc from its bed, with care taken to preserve the vascular tree underneath. Finally, the anterior tibial neurovascular bundle was traced for

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TABLE I

Summary of Data of the Cadavers and Morphologic Structure of the Extensor Digitorum Brevis

						Extensor Digitorum Brevis Muscle			
	Age	Sex	Height (cm)	Foot Length (cm)	Specimen	Length (cm)*	Width (cm)*	Height (cm)*	Surface (cm^2)†
1	80	M	168	25	1R	5	3.8	1	19
					1L	4.6	4.1	0.9	18.86
2	62	M	164	24	2R	4.3	3.3	0.9	14.9
					2L	4.2	3	0.7	12.6
3	18	F	165	22	3R	5.2	4	1	20.8
					3L	5.6	3.9	0.9	21.8
4	79	M	168	24	4R	3.9	3	0.75	11.7
					4L	4	2.9	0.7	12.8
5	70	M	163	24	5R	3.6	2.3	0.6	8.28
					5L	3.9	2.1	0.5	8.19
6	25	M	193	28	6R	6	4.2	1.2	25.2
					6L	6.1	4.7	1	28.67
7	69	F	155	25	7R	5.4	4.6	0.9	24.84
					7L	4.2	3.9	0.8	16.38
8	74	M	163	26	8R	4.6	4.2	0.8	19.32
					8L	5.5	4.6	0.6	25.3
9	44	M	164	24	9R	4.8	4.6	0.9	22.08
					9L	5.6	4.4	0.9	24.64
10	44	M	178	28	10R	6.1	4.2	1	25.62
					10L	6.7	3.5	1.1	23.45
11	25	M	171	26	11R	5.5	4.3	1.1	23.65
					11L	6.2	3.7	1.2	22.94
12	49	M	177	26	12R	6	4.4	1.1	26.4
					12L	6	3.8	1	22.8
13	60	F	159	23	13R	4.8	3	0.6	14.4
					13L	5	3.6	0.6	18
Mean						5.13	3.76	0.88	19.72
Maximum						6.7	4.7	1.2	28.67
Minimum						3.6	2.1	0.5	8.19
Standard deviation						0.85	0.70	0.19	5.74

* All measurements were made taking the average between maximum and minimum.
† The surface is calculated with the product length × width.

approximately 10 cm, and an attempt was made to cover the Achilles tendon area with the proximally based island extensor digitorum brevis, following medial and lateral[1] pathways. The extensor digitorum brevis muscle–neurovascular bundle complex was then removed from the body. On a side table, the length and external diameter of the various structures were measured with a ruler and a Vernier caliper, respectively. The data were rounded to the nearest 0.1 cm or 0.1 mm, as applied.

Harvesting Technique

The harvesting technique has been presented in detail previously.[1,4,5,7] Nevertheless, through our laboratory and clinical work, we developed the following technical steps (Fig. 1).

Step 1: Lateral tarsal isolation. Through a zigzag incision, slightly lateral to the anterior tibial bundle, we located the lateral tarsal artery takeoff in the cleft between the extensor digitorum longus and extensor hallucis longus tendons. We then proceeded laterally, freeing this vessel first up to and then under the extensor digitorum brevis muscle as much as possible. The dorsalis pedis and deep peroneal nerve are dissected at this stage as required.

Step 2: Superficial surface dissection. This part of the procedure is performed in the plane between the extensor tendons and the muscle. The superficial peroneal nerve and the peritenon of the extensor digitorum longus tendons should be preserved carefully.

Step 3: Deep surface dissection. After cutting the distal tendons of the extensor digitorum brevis, the ends are joined together and retracted as a group to prevent individual slips from separating from one another.[7] The undersurface of the extensor digitorum brevis is then dissected. Some concerns may arise here from the presence of myriad thin-walled vessels over the tarsal bones that tear easily and may slow down the procedure unless they are disregarded. Although these vessels can be a source of concern for the surgeon, it should be remembered that the lateral tarsal artery was already partially dis-

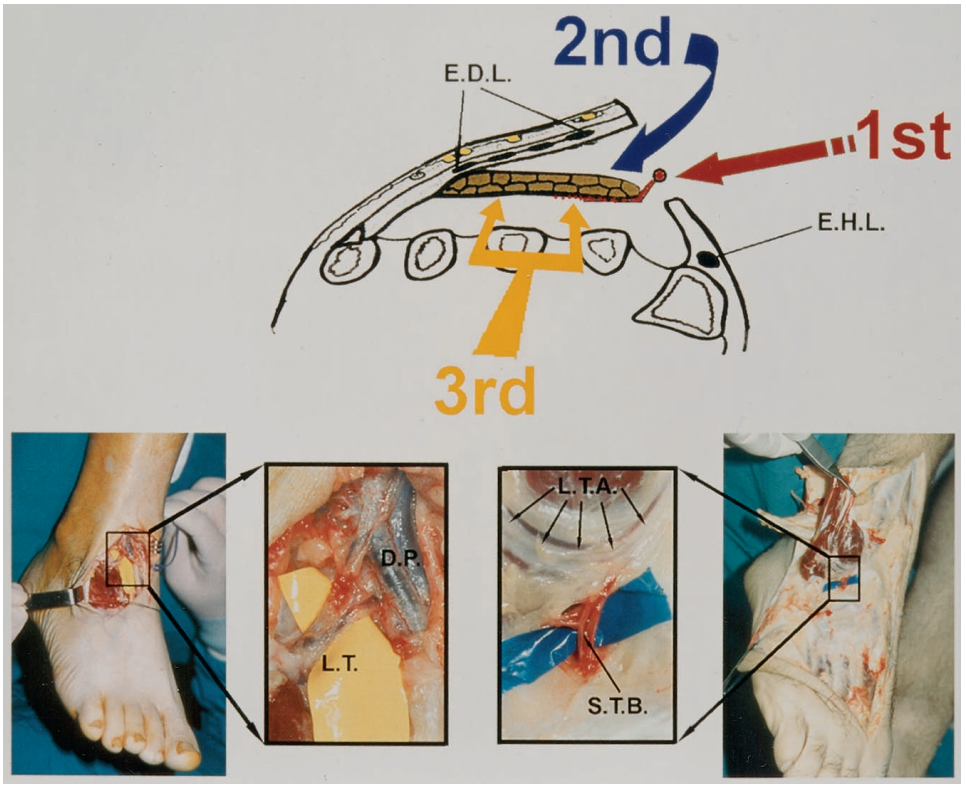

FIG. 1. (*Above*) Diagram of the three-step harvesting technique: (1) lateral tarsal artery isolation, (2) superficial aspect freed from the paratenon of the extensor digitorum longus tendons and superficial peroneal nerve branches, and (3) deep surface dissection. EHL, extensor hallucis longus; EDL, extensor digitorum longus. (*Below left*) Intraoperative view after completion of steps 1 and 2. LT, lateral tarsal; DP, dorsalis pedis. (*Below right*) Anatomic preparation highlighting the branch to the sinus tarsi. LTA, lateral tarsal artery; STB, sinus tarsi branch.

sected (step 1). The key point of the operation is locating and ligating a fairly constant branch of the lateral tarsal artery to the sinus tarsi. This is an extremely short and fragile vessel, and damage to it may put at risk the lateral tarsal artery proper (Fig. 1, *below, right*). Once this difficulty is overcome, the procedure is quickly terminated by first ligating the lateral tarsal artery at the most lateral aspect and then elevating the muscle from its origin.

RESULTS OF THE ANATOMIC STUDY

The data from this study are presented in detail in Tables I and II. It is of note that the lateral tarsal artery is the main blood supply to the extensor digitorum brevis muscle. It is significant in diameter (1.83 mm ± 0.35) but small in length (1.89 cm ± 0.69). Nevertheless, it can be used with the dorsalis pedis artery, which is of greater diameter (3.25 mm ± 0.62). Although the anatomy may vary after the origin of the lateral tarsal artery, we were able to track the dorsalis pedis artery distally up to the first web space in every case, for a mean length of 6.77 cm ± 0.99.[11] The first dorsal metatarsal artery was superficial in 19 of 26 cases (73 percent).

The dorsalis pedis venae comitantes were also examined and, at the level of the lateral tarsal artery, were 1.6 ± 0.44 mm in diameter. Just before branching at the muscle, the deep peroneal nerve had an external diameter of 2.13 ± 0.48 mm. The motor branch itself had a diameter of 1.55 ± 0.40 mm and penetrated into the muscle in the same hilus as the artery and vein. The latter branch was found to be the only nerve that entered the muscle.

CASE REPORTS

Case 1: Flow-Through Free Flap

A 22-year-old male construction worker was referred for amputation 3 weeks after sustaining a massive crush of his right wrist. On presentation the hand was numb, cold, and painful. Total necrosis of the intrinsic muscles and diffuse infection were evident. Doppler signal was absent at the wrist level in the radial, ulnar, and digital arteries. After debridement there was a huge dead space and exposure of all metacarpals, which were devoid of periosteum. Despite the damage, the option of hand salvage was discussed with the patient

TABLE II
Results of the Vascular Study*

	Dorsalis Pedis Artery					Lateral Tarsal Artery		Accessory Artery	DP–AT Venae Comitantes Diameter (mm)			
	Diameter (mm)								Level of LTA		3 cm above LTA	
	Proximal to LTA	Distal to LTA	At FDMTA	Length (cm)‡	FDMTA (S/D)§	Diameter (mm)	Length (cm)	Diameter (mm)	LAT	MED	LAT	MED
Specimen												
1R	3.5	3	3	6.5	S	1.6	2.2	0	1.5	2.6	1.6	2.7
1L	3.6	2.8	2.8	7	S	2.1	1.5	0	1	2	1.1	2
2R	2.8	2.8	2.4	6.9	S	1.8	1.6	0	2.4	2.2	2.5	2.3
2L	3	2.9	2.1	7.7	S	1.9	2	0	1.5	2.2	1.8	2.5
3R	2.4	2.2	1.8	6.1	D	1.4	1.5	0	2.1	1.4	2.7	1
3L	2.5	2.2	1.6	6.4	D	1.1	2.2	0.4	2.1	1.3	1.8	1.2
4R	4	3.9	2.9	7.8	S	2.7	1.1	0	1.6	1.7	1.9	1.9
4L	3.8	3.6	3	5.8	D	1.8	1.1	0	1.3	1.6	1.3	1.9
5R	3	3	2.4	7.4	D	2	1.3	0	2.8	2.1	3	2.5
5L	3	2.9	2.4	7.4	D	1.5	1.5	0	2	2	3	1.9
6R	3.3	2.7	2	8.3	S	2.2	1.9	0	1.8	1.7	1.9	1.7
6L	3.1	3	2.1	7	S	1.6	2.1	0.2	2	1.1	1.9	2
7R	2.9	2.4	2	5.9	S	1.8	1.8	0.5	1	1.2	1.2	1.2
7L	2.9	2.6	1.8	5.4	S	1.7	2	0.6	1	1.5	1	1.6
8R	4	3	1.8	8.4	S	2.5	3.8	0.8	1.6	2	1.5	2
8L	3.8	2.5	2.2	8.2	S	2.4	2.7	0.7	1.4	1	1.7	1.2
9R	4	3	2.7	7.9	S	1.9	1.8	0.8	1.5	1.5	1.7	1.5
9L	5	3.9	2.4	7.4	S	2	3.3	0	2	2.5	2.5	3
10R	2.5	2.3	1.5	7.3	S	1.7	1.6	0.9	1.4	2.3	1.6	2
10L†	2.5	2.3	1.4	5.6	D	1.5	0.5	0	1.8	1.2	1.4	1.5
11R	2.5	2.4	2	5.1	S	1.6	2.2	0	1	1.2	1.7	1.6
11L	3	2.9	2	5.8	S	1.6	1.5	0.9	1.7	1.6	1.8	1.9
12R	3.6	3.5	3	7.1	S	1.9	2.1	0	1.3	1.9	2	1.6
12L†	3.5	3.4	2.5	5.2	S	1.6	1.3	0	1.4	2	1.5	2
13R	3.5	3	2.5	6.4	S	1.8	2.6	1	1.5	1.4	2	1.8
13L	2.8	2.6	2.5	6	D	2	1.9	0	1.9	1.4	2.4	1.8
Mean	3.25	2.88	2.26	6.77		1.83	1.89		1.6	1.7	1.9	1.9
Maximum	5	3.9	3	8.4		2.7	3.8		2.8	2.6	3	3
Minimum	2.4	2.2	1.4	5.1		1.1	0.5		1	1	1	1
Standard deviation	0.62	0.48	0.47	0.99		0.35	0.69		0.44	0.44	0.53	0.48

* FDMTA, first dorsal metatarsal artery; LTA, lateral tarsal artery; DP-AT, dorsalis pedis–anterior tibial; LAT/MED, lateral/medial.
† Absent anterior tibial artery.
‡ This measurement spans from the origin of the LTA to the deep plantar division.
§ Superficial/deep.

and family. The flap procedure was performed 48 hours later. The patient's hand was revascularized with an extensor digitorum brevis flow-through free flap that also helped to close the dead space. Immediately after the procedure the pain abated, the hand rewarmed, and sensibility improved. Further procedures were performed later to restore opposition with an abductor hallucis functioning free flap. Infection had not recurred at the latest (4-year) follow-up. The extensor digitorum brevis flow-through flap continues to be the main arterial supply to the hand.

Case 2: Vascularized Nerve Graft

A 44-year-old woman had sustained an injury with a heating press 18 months before referral (Fig. 2). The patient was most troubled by an adhered skin graft on her palm, which was so tender that she could not grasp any object. Anesthesia on the radial side of the index finger was also noticed. During surgical exploration, it was found that the second commissural nerve and the radial digital nerve were intimately adhered to the skin graft, the latter being discontinuous. To reconstruct the palmar defect (4 × 4 cm) and the gap in the radial digital nerve of the index finger (5-cm), a combined extensor digitorum brevis-deep peroneal nerve was selected. The former provided padding and coverage. The nerve gap was resolved by two cable nerve grafts, one of which was vascularized. Postoperatively, we noticed good progression of Tinel sign up to the pulp; also, sweating and pain responses were recovered. The patient nevertheless denied any benefit from the operation. Compensation claiming was the only explanation we could find for the disagreement between exploration and the reported anesthesia.

Case 3: The "T Interposed Extensor Digitorum Brevis": A Modification For Anterior Tibial Artery Sparing

A 40-year-old male rail company worker was referred 1 month after an operation for a closed ruptured Achilles tendon. The edges of the surgical wound necrosed and the tendon repair was exposed and infected. The wound was debrided and immediately covered with an extensor digitorum brevis flap from the other foot. Only a small segment (1.5-cm) of the donor anterior tibial artery was taken with the flap and interposed in a T fashion in the posterior tibial artery with two end-to-end anastomoses (Fig. 3). The donor anterior tibial artery was repaired end-to-end. No complications were recorded. At 1-year follow-up the donor anterior tibial artery continues to be patent.

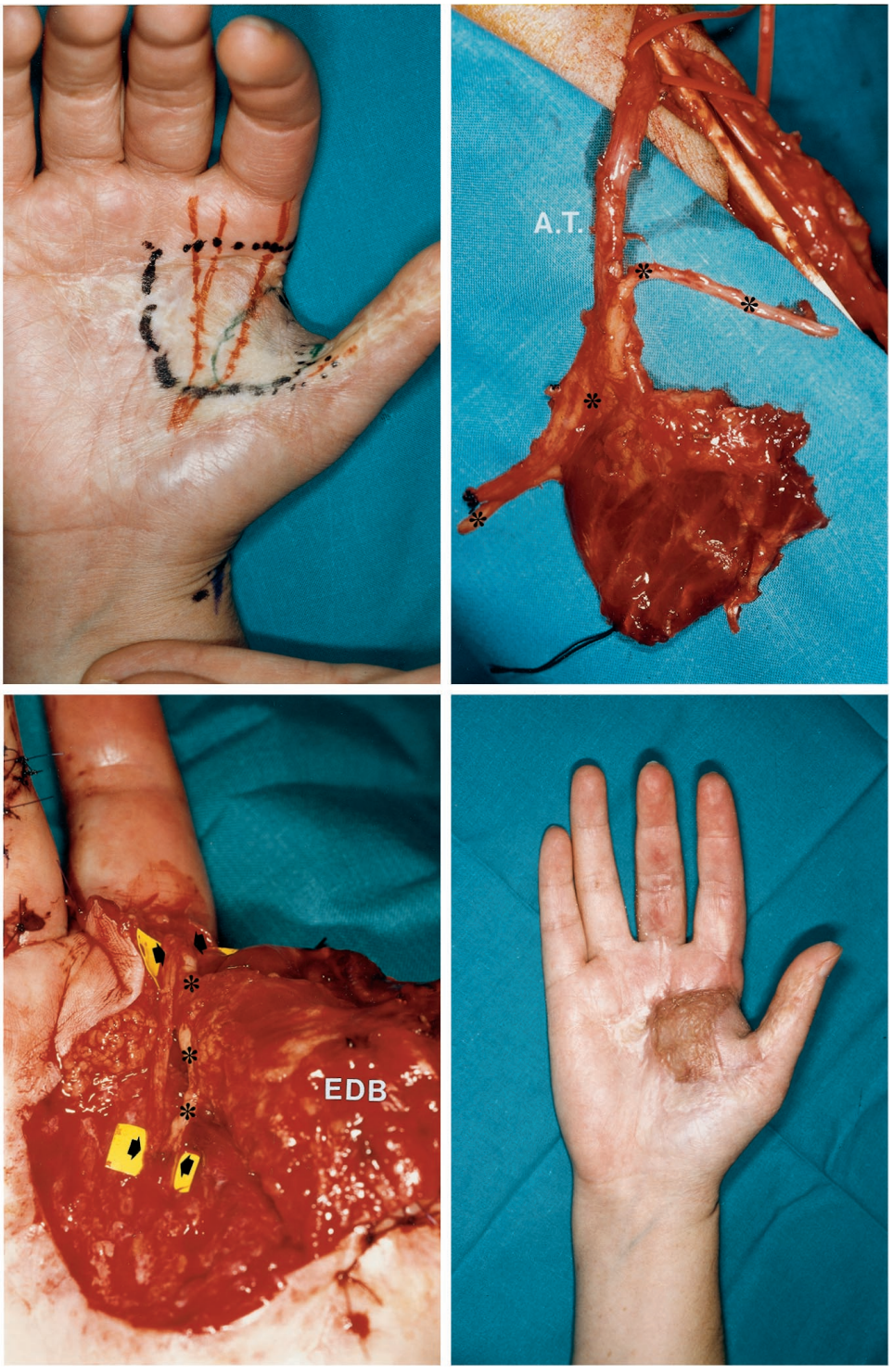

FIG. 2. Painful skin-grafted area in the palm in case 2 (*above, left*). (*Above, right*) Intraoperative photograph. The extensor digitorum brevis-deep peroneal vascularized nerve graft (*asterisks*) is still pedicled on the anterior tibial bundle (*AT*). (*Below, left*) Intraoperative photograph of the flap already revascularized in the hand. The extensor digitorum brevis is reflected radially, exposing its undersurface. The gap in the digital nerve is marked by *arrows* and the deep peroneal vascularized nerve graft by *asterisks*. (*Below, right*) Early result showing the stable skin-grafted extensor digitorum brevis.

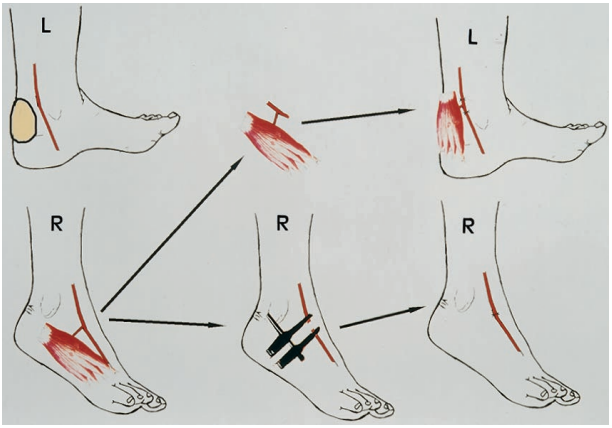

FIG. 3. Summary of the procedure performed in case 3. From left to right, the extensor digitorum brevis muscle is harvested from the right foot (*R*) and transferred to the left foot (*L*) with only a small segment of dorsalis pedis artery. The artery is repaired in the donor side.

Case 4: Bilobed Dorsalis Pedis Fasciosubcutaneous-Extensor Digitorum Brevis Muscle Free Flap

A 44-year-old male punch press operator suffered a crush injury with a heating press to his left hand and forearm (Fig. 4). He sustained a third-degree burn to his palm and dorsum; the second finger was charred; and compartment syndrome was diagnosed on his third finger, hand, and distal forearm. After debridement, decompression of the compartments, second-ray amputation, and third extensor reconstruction, a huge palmar and dorsal defect was evident. Coverage was done immediately to protect the palmar arch and commissural arteries, which were exposed and devoid of adventitia. A bilobed dorsalis pedis fasciosubcutaneous-extensor digitorum brevis combined flap was selected: the muscle for the palm and the subcutaneous part for the dorsum. The foot was closed primarily. Delayed but complete healing of the donor site was achieved.

DISCUSSION

The extensor digitorum brevis is a trapezoid muscle that spans from the lateral aspect of the calcaneus to the first four toes.[17,18] We, as well as other investigators,[19] have been unable to consistently find an independent muscle belly that may be called the extensor hallucis brevis[6]; rather, we have noted a uniform proximal muscle mass that divides into several bellies in its distal third.

The arterial supply on the medial edge of the muscle was carefully studied in the cadavers. In agreement with other investigators,[4,5,19] we found in 100 percent of specimens that the dominant blood supply to the extensor digitorum brevis was provided by the lateral tarsal artery.

The origin of the lateral tarsal artery has been described as being at or below the lower edge of the inferior extensor retinaculum.[1,7,11] Inasmuch as its precise location is critical for a smooth dissecting technique, we investigated its true relationship to this landmark. Our results indicated that the origin of the lateral tarsal artery is higher than reported above and is better allocated at the level of the talocrural joint.

When searching for secondary pedicles, we purposely disregarded the tiny branches of the dorsalis pedis that on their way to the skin have a casual relation to the muscle[20]; from a surgical standpoint they are irrelevant. This may explain why we were unable to find accessory (secondary) arteries in the medial edge of the muscle in 55 percent of the specimens (Fig. 5). Although we did not investigate in detail the lateral blood supply of the muscle,[21] we could determine that after passing under the muscle the lateral tarsal artery did anastomose with other arteries on the lateral region of the foot. The lateral tarsal artery is accompanied by venae comitantes, which always drain to the anterior tibial veins, sometimes as two independent veins and sometimes forming a rete of veins. Measurements of the anterior tibial veins were taken at two levels: where they were joined by the lateral tarsal veins and 3 cm proximally (Table II). However, it must be noted that these measurements are for descriptive guidance only; we know from previous investigations in the deep venous system[22] that even in injected specimens the recorded diameters of the veins are very variable and tend to be smaller than in those of live subjects.

Coverage of the Achilles tendon by the proximally pedicled extensor digitorum brevis was attempted in all of the cadavers in this study and was found to be inconsistent. Although coverage was uncomplicated in about 40 percent of the cadavers, in several the extensor digitorum brevis simply did not reach the calcaneus–Achilles junction; in others, only the thinnest distal part of the muscle reached the area.

We found an absence of the anterior tibial artery in two specimens (10L and 12L), which is in the average 5 percent of results found in larger studies.[23] In both cases the anterior tibial artery was taken over by a large, perforating branch of the peroneal artery, which continued on the foot as a dorsalis pedis. Also in both cases, the lateral tarsal artery and the dorsalis pedis were shorter than in the normal side and shorter than the average, which may impose some limitations when using the T graft and

FIG. 4. Case 4. The condition after debridement and release of the compartments (*above, left two panels*). (*Above, center*) Elevated fasciosubcutaneous dorsalis pedis portion of the flap. (*Above, right*) The bilobed dorsalis pedis-extensor digitorum brevis muscle flap is now pedicled on the vessels. (*Below*) Result at 8 months.

flow-through variants. Although we have not been confronted with this scenario in clinical practice, we would not hesitate to sacrifice the dorsalis pedis (now dependent of the perforating peroneal) provided that two conditions are met: (1) the posterior tibial pulses are detected preoperatively in the maleollus while occluding the dorsalis pedis on the foot; and (2) upon releasing the tourniquet and having clamped the dorsalis pedis, normal refilling of the foot is seen. Interestingly, when this anatomic variant was encountered no problem was found in covering the Achilles–calcaneus junction or even the posterior aspect of the calcaneus.

The extensor digitorum brevis muscle has small covering area capabilities (about 20 cm^2 in our study). It has been widely used as a free flap for covering small defects[3,7,12] or for functional restoration.[13–16] From our anatomic work we have been able to expand its use as follows:

Flow-Through Free Flap

The surgeon may at times find it necessary to cover and revascularize during an operation. Taylor and Ham[24] introduced the concept of the blood carrier flap, and several authors subsequently expanded and refined its use.[25,26] The extensor digitorum brevis flap is ideally suited for this purpose, especially in the hand trauma setting, wherein the merits of arterial autografts to reconstruct arterial defects are self-evident.[27] Not only are the vessels an excellent match for those of the hand, but the size

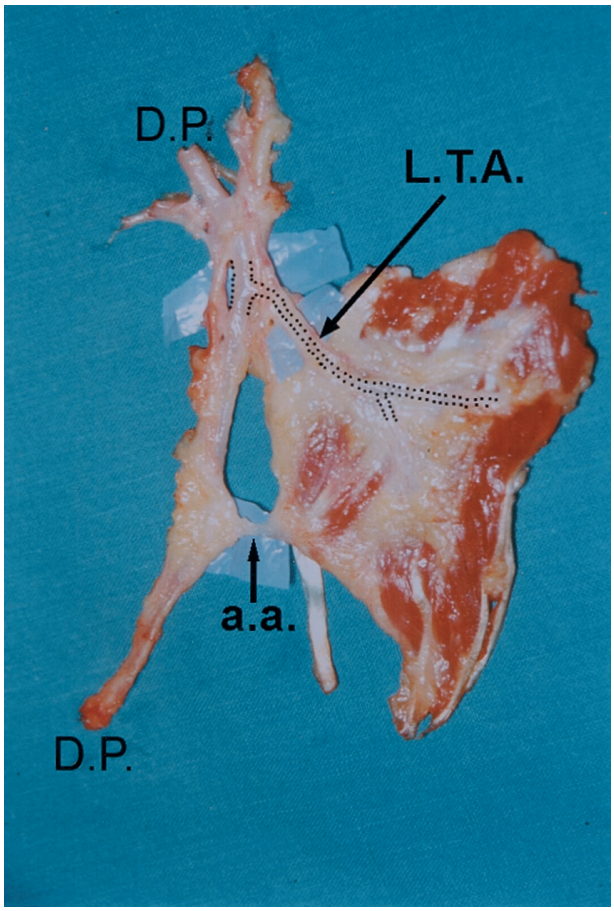

FIG. 5. Anatomic preparation showing the underside of the extensor digitorum brevis. The lateral tarsal artery is highlighted by *dots*. Note the awkward location of the accessory pedicle (*aa*). DP, dorsalis pedis; LTA, lateral tarsal artery.

of the muscle is quite appropriate for hand defects (Fig. 6). The flap, from the origin of the lateral tarsal artery to the deep plantar division, is benefited by 6.77 cm (SD ± 0.99) of artery homogeneous in diameter. This length is even longer if the patient has a superficial first dorsal metatarsal artery (as in 73 percent of cases in our series).

Vascularized Nerve Graft

Controversies exist with regard to the indications for a vascularized nerve graft.[28] There is, however, no doubt that a prime indication for a vascularized nerve graft is a badly scarred bed, such as that found after a deep dermal burn.[28,29] The extensor digitorum brevis-deep peroneal vascularized nerve graft adds to the benefits of providing coverage that better resists shearing stresses[30] as well as a time-tested vascularized nerve graft.[31–33] These properties make this combination the first choice for reconstruction of palm (or sole) defects when there is an associated nerve gap, as in case 2 reported here.

The T Interposed Extensor Digitorum Brevis: A Modification for Anterior Tibial Axis Sparing

To avoid the drawback of sacrificing a major arterial trunk (anterior tibial) to the foot when harvesting the extensor digitorum brevis, we devised an alternative procedure: A segment of only 1.5 cm of anterior tibial artery, which included the lateral tarsal artery takeoff, is interposed in the recipient artery as a T graft, and the donor artery is reconstructed end-to-end. This modification has the disadvantage of requiring three anastomoses, but the artery is of large diameter and a more physiologic through-flow[34] is achieved. The T interposed extensor digitorum brevis modification requires a nearby major arterial trunk because the pedicle is short (about 2 cm, see Table II). On the other side, an unlimited length of veins

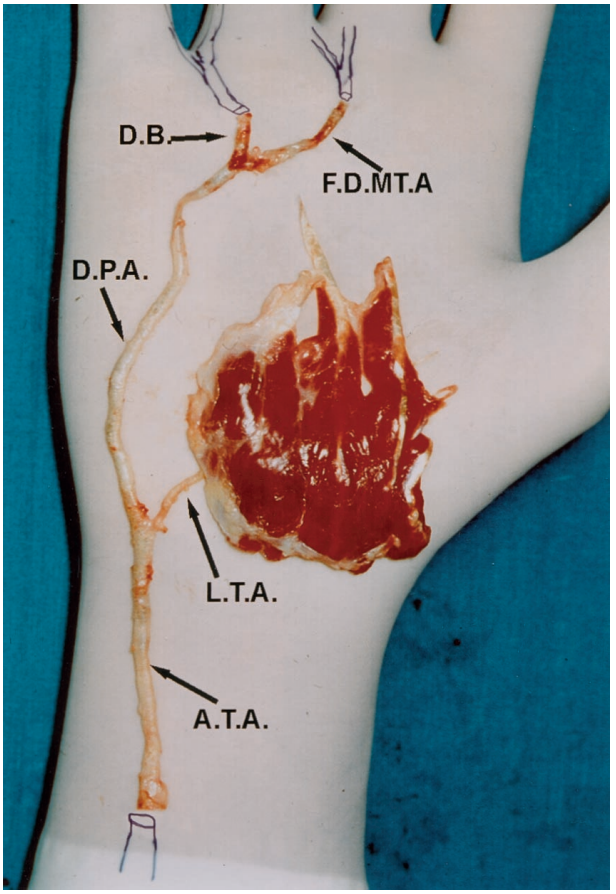

FIG. 6. The deep plantar branch and the first dorsal metatarsal arteries are to be connected, in this simulation in the cadaver, to the commissural arteries. ATA, anterior tibial artery; LTA, lateral tarsal artery; DPA, dorsalis pedis artery; DB, deep branch of the dorsalis pedis; FDMTA, first dorsal metatarsal artery.

(anterior tibial veins) is available for performing the anastomoses distant to the area of injury.

Bilobed Dorsalis Pedis Fasciosubcutaneous-Extensor Digitorum Brevis Free Flap

Combined palmar and dorsal defects in the hand pose a tremendous challenge. A flap composed of two independent leaves may be ideal for solving the problem. Our anatomic investigations allowed us to refine Ismail's work on the use of the dorsalis pedis myofascial flap.[35] First, to increase the size of the fasciosubcutaneous part of the flap, not only the dorsalis pedis but also the first dorsal metatarsal artery was included, allowing a much larger flap. Second, the full extensor digitorum brevis mass was included to increase the coverage area. Finally, by dissecting the lateral tarsal pedicle from the dorsalis pedis, independent rotation among the two flap components was permitted, i.e., a true island bilobed flap was created.

Because the anterior tibial, the dorsalis pedis, and the first dorsal metatarsal arteries are, in essence, on the same vascular axis, and because any of the above named trunks may be the source of multiple free flaps, countless combinations are possible.[8,12,14,16] Although it may seem obvious, we must emphasize that the limiting factor for these capabilities is the donor site sequela, which should be considered at all times so as not to exacerbate the problem.

In conclusion, we think that the extensor digitorum brevis flap is excellent for repairing small defects. Future developments and applications will surely expand its use even more.

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