



## Introduction

Wide-awake anesthesia without the use of a tourniquet or sedation is widely used in hand surgery. This procedure is well described by WALANT, the wide-awake local anesthesia no tourniquet technique [1, 2]. The only two medications required for treatment would then include lidocaine for anesthesia and epinephrine for hemostasis. In addition, the technique provides additional benefits such as eliminating the need for intravenous insertion, constant monitoring, routine preoperative testing, and fasting for the patient.

The advent of increasingly safe general anesthesia before 1950 generated the era of bloodless tourniquet hand surgery that dominated the field for the past 15 years. Although it was once taboo, the early 2000s brought solid evidence that epinephrine hemostasis in the finger and hand is safe [2–5] and that the use of the tourniquet and its requirement for sedation are no longer essential to perform hand surgery.

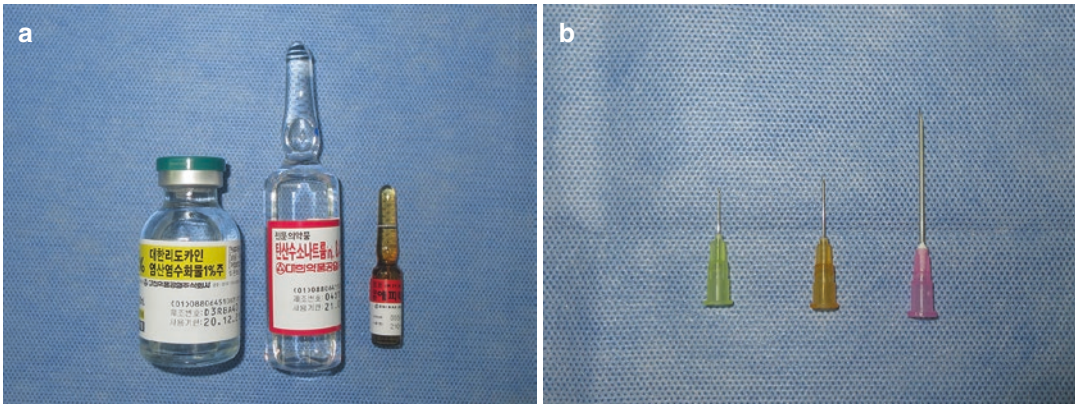
**Electronic Supplementary Material** The online version of this chapter ([https://doi.org/10.1007/978-981-10-4400-7\\_12](https://doi.org/10.1007/978-981-10-4400-7_12)) contains supplementary material, which is available to authorized users.

M. J. Yoo (✉) · S. H. Woo  
W Institute for Hand and Reconstructive  
Microsurgery, W Hospital, Daegu, South Korea

## Dosage of Local Anesthesia in Wide-Awake Surgery of the Thumb

The use of tumescent local anesthesia to a tourniquet-free extravascular Bier block in which subcutaneous injections of lidocaine with epinephrine are administered only when necessary. In this technique, the epinephrine substitutes the tourniquet to achieve hemostasis. Although some literature supports the safe use of 35 mg/kg of lidocaine with epinephrine [6], the generally accepted maximal dose is 7 mg/kg. Therefore the average 70 kg person can safely receive 50 cc 1% lidocaine with epinephrine. This mixture remains quite effective when diluted with up to 150 cc of saline to attain the frequently used 0.25% lidocaine with 1:400,000 epinephrine [7].

Special precaution must be taken with the volume so that “top-ups” are never required. If 50 cc or less is needed, the use of 1% of lidocaine with 1:100,000 epinephrine is recommended. If anywhere between the ranges of 50 and 100 cc is required, 0.5% lidocaine with 1:200,000 epinephrine will be satisfactory. For any necessary quantities between 100 and 200 cc, the use of 0.25% lidocaine with 1:400,000 epinephrine is ideal. Concentrations of bicarbonate are used to neutralize the acidic average pH of 4.7 of 1% lidocaine with 1:100,000 epinephrine, but the preferred ratio is 10 cc lidocaine to 1 cc 8.4% bicarbonate to decrease injection pain [8] (Fig. 12.1).



**Fig. 12.1** (a) The anesthetic solution used for injection (1% lidocaine, 1:100,000, 8.4% bicarbonate, epinephrine), (b) the injection needle (30-gauge needle, 25-gauge needle, and 18-gauge needle)

### Minimal Pain Injection Tumescent Local Anesthesia

A 27-gauge needle causes less pain going in the patient's skin than a 25-gauge needle, and it helps remind the injector to slow down. The injector should start by injecting 2 cc slowly, just below the skin. The use of 30-gauge needles for children or patients who are particularly sensitive is recommended. The pain can be alleviated by creating sensory noise in the area of injection which is icing the skin or vibrating.

Nerves in the dermis are akin to trees with sensitive leaves, and the fatter areas to sturdier branches and tree trunks. So administering the injection in the dermis causes more pain than in subcutaneous fat. When the needle is inserted, an injection of 0.5 mL with a perpendicular needle just under the dermis and pausing until the patients say the needle pain is gone is advisable.

Also, precaution must be taken to never let the needle get ahead of the local anesthetic [9]. If this happens, the sharp needle tip will irritate nerve endings that have not been numbed. As a precautionary measure, the mental repetition of a phrase such "blow slow before you go" while injecting the area will assist in slowing down and exercising patience. If the injection is administered in an antegrade direction while advancing gradually and steadily under the skin, the sharp needle tip will only enter numbed territory.

### Technique for Injecting Local Anesthesia

The local anesthetic is injected in the digits of the patient in the waiting area, 30 min prior to applying anesthesia. The injection starts proximally with a fine needle (25- or 30-gauge). Between 10 and 15 mL of infiltration is injected in the most proximal part next to the area likely to be dissected to block the nerves distally. In this way, the large volume of the first injection will bathe all of the nerves leading to the area of later injections. In making the first injection, the needle is inserted perpendicularly to the skin into the subcutaneous fat to reduce the pain of injection [10]. The syringe is then stabilized by propping the fingers on the skin to avoid needle wobble. The first 0.5 mL is injected for a duration of 5 s and followed by a 15–45 s pause, until the patient reports that the sting is gone. The rest of infiltration is then injected very slowly, for a duration of more than 5 min, while keeping the needle still. About 10–15 min after the first injection, the whole distal area of dissection is almost or completely numb. As a result, the next injections will be pain-free. The next three injections are used mainly for the epinephrine vasoconstriction effect for digital nerves.

In the finger, the 1% lidocaine with 1:100,000 epinephrine is injected into the subcutaneous fat in the middle of the base of the phalanges,



**Fig. 12.2** Wide-awake local anesthesia for flexor pollicis longus (FPL) in the thumb. (a) Between 10 and 15 mL of 1% lidocaine with 1:100,000 epinephrine buffered with 10:1 8.4% bicarbonate is injected with a 27-gauge needle in the palm more proximal than the most proximal incision possible. The local anesthesia is injected slowly just under the skin in the fat without moving the needle. (b)

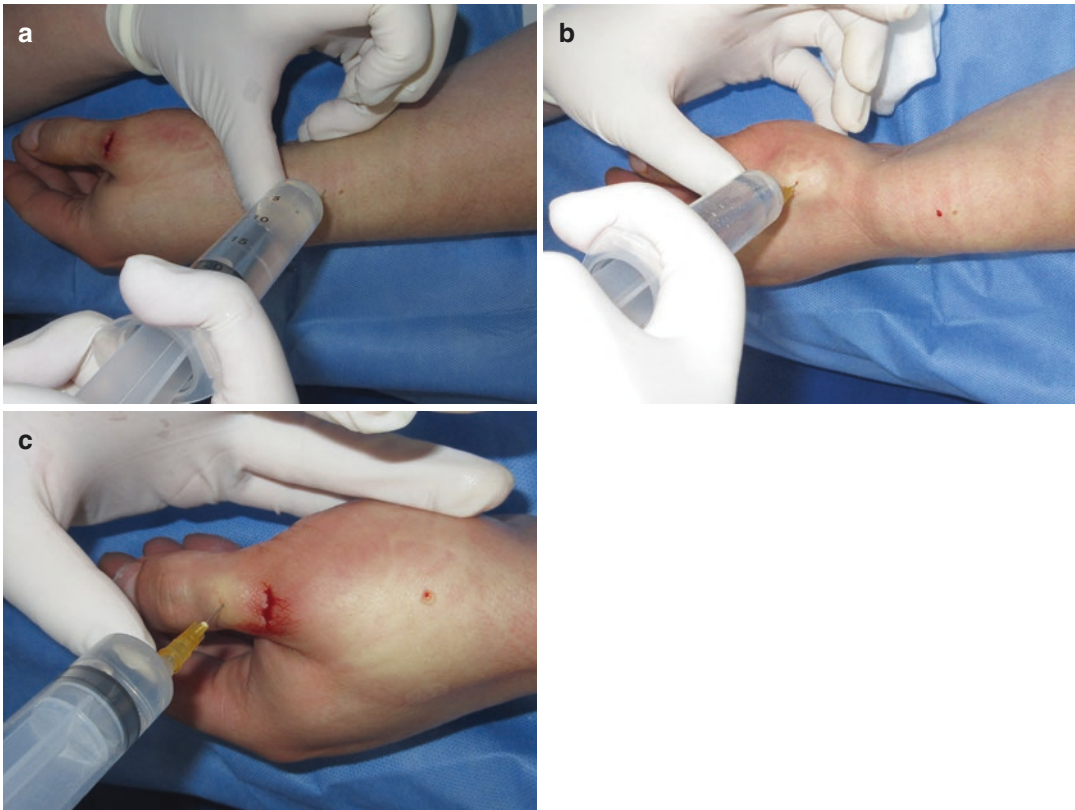
Fifteen minutes after the first injection, the second injection (10 mL) was performed subcutaneously at the more proximal palmar area between both digital nerves. (c) The final injection (2 mL) was performed immediately after the second injection under the skin at the palmar digital crease between both digital nerves

between both digital nerves. This ensures that the bevel of the needle does not lacerate the fascicles. In the proximal and middle palmar phalanges, 2 mL is injected. In the distal phalanx, 1 mL is injected. The routine injection of 10–15 mL in the palm follows wherever dissection will be performed (Figs. 12.2 and 12.3) (Video 12.1).

### Advantages of WALANT

There are several advantages of flexor tendon repair in wide-awake surgery. The most important advantage is intraoperative testing which can

reveal the gapping of a weak repair and decrease rupture rates [11]. These repairs get less tenolysis because intraoperative testing of the repair guides the surgeon to vent pulleys that impede the full flexion or extension of the thumb [12]. Surgeons can educate the lucid patient during surgery, so they understand how to avoid rupture and getting stuck [13]. Intraoperative flexor tendon repair testing guides the surgeon in the decision to maintain a superficialis repair or resect a superficialis slip [14]. Seeing full active flexion and extension with no gap during the surgery empowers the surgeon to allow up to half a fist of true active postoperative flexion (not place and hold) 3–5 days after surgery [15].



**Fig. 12.3** Wide-awake local anesthesia for extensor pollicis longus (EPL) tendon in the thumb. (a) Between 10 and 15 mL of 1% lidocaine with 1:100,000 epinephrine buffered with 10:1 8.4% bicarbonate is injected with a 27-gauge needle in the palm more proximal than the most proximal incision possible. The local anesthesia is injected slowly just under the skin in the fat without moving the

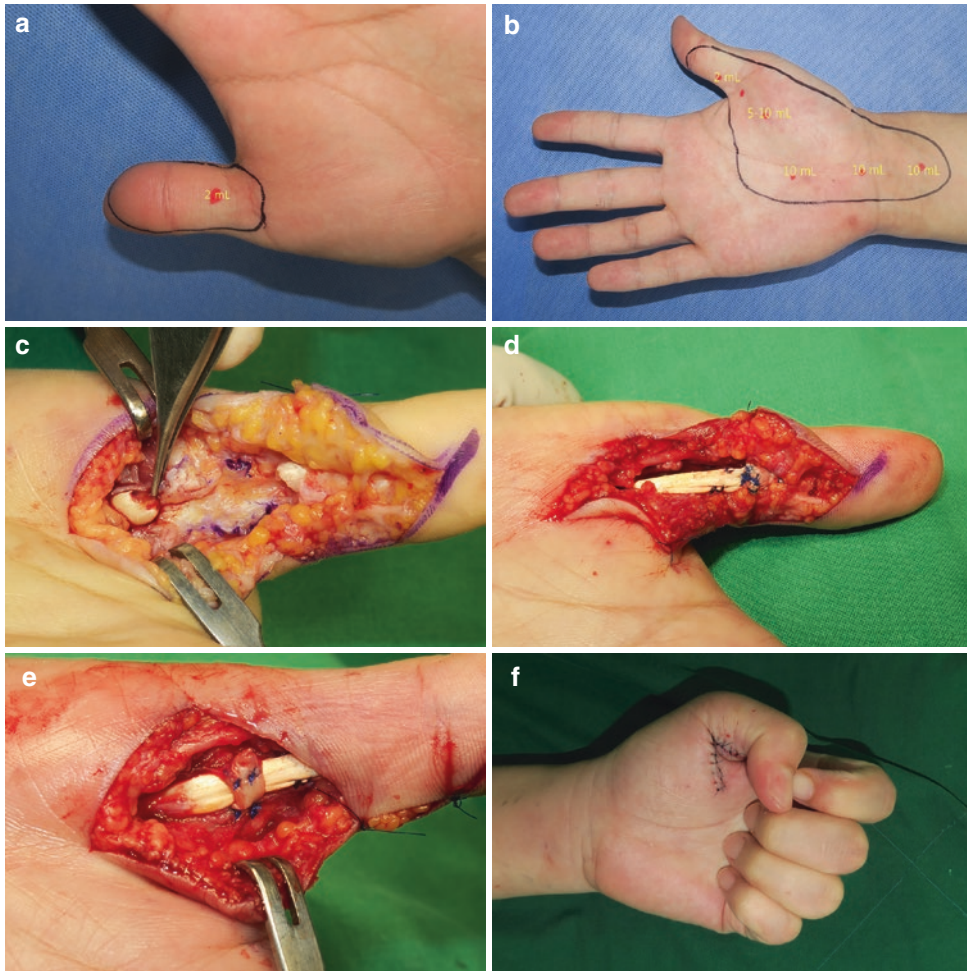
needle. (b) Fifteen minutes after the first injection, the second injection (10 mL) was performed subcutaneously at the more proximal palmar area between both digital nerves. (c) The final injection (2 mL) was performed immediately after the second injection under the skin at the dorsal proximal phalanx of the thumb

### Flexor Pollicis Longus (FPL) Repair of the Thumb

When the proximal ends of the tendon are pulled out to length, patients will sometimes actively pull the flexor tendon away from the surgeon. This is usually easily dealt with by asking the patient to relax the finger. If that does not work, the patient is asked to actively extend the finger, which causes a reflex that relaxes the involved flexor tendon. The flexor tendon is then brought out to length and skewered into position with 22-gauge hypodermic needles [14]. The flexor pollicis longus (FPL) tendon is repaired with a six-strand core suture repair (Prolene 4–0 suture, M-Tang method using looped suture, or

M-Becker's method). Repeatedly testing the patient's full active flexion and extension of the thumb after each core and epitenon suture is advised to make sure that there is no gap and that the repair fits through the pulleys. Before the skin closure, there are three tests that should be conducted: full active extension to verify that there is no gapping between the tendon ends; smooth active flexion to verify smooth gliding of the tendon and its repair site; and active flexion to almost fully flex the digit to verify that no pulley prevents tendon gliding. Surgeons can repair any gaps and vent pulleys as required to get a full range of motion [16]. In postoperative therapy, immobilize and elevate the hand until swelling, friction, and the work of flexion are





**Fig. 12.4** (a) Simple distal thumb block. When you inject 2 mL of 1% lidocaine with 1:100,000 epinephrine (buffered at a ratio 10 mL of 8.4 sodium bicarbonate) in subcutaneous fat in the red spot point. (b) The flexor pollicis longus (FPL) in carpal tunnel may benefit from a median nerve block of 10 mL of 1% lidocaine with 1:100,000 epinephrine and 1 mL of 8.4% sodium bicarbonate under the skin and under the distal forearm fascia in the proximal red spot. Up to 20 mL of the same solution would go in the palm, starting with 10 mL over the carpal tunnel, then 10 mL over the thenar eminence, and 2 mL in the thumb

proximal phalanx injection point just under the skin. (c) A 39-year-old patient hurt by a knife ruptured the flexor pollicis longus (FPL). Thirty minutes after the local anesthesia injection, the epinephrine takes effect. The wound was exposed through the A1 pulley stepladder and was opened. (d) This FPL shown was repaired with a 6-strand M-Tang technique. (e) After FPL repair, the patient actively extended and flexed the thumb to perform the extension-flexion test. A1 pulley was reconstructed with fourth FDS radial slip about bowing of FPL. (f) After skin suture, the patient actively flexed the thumb

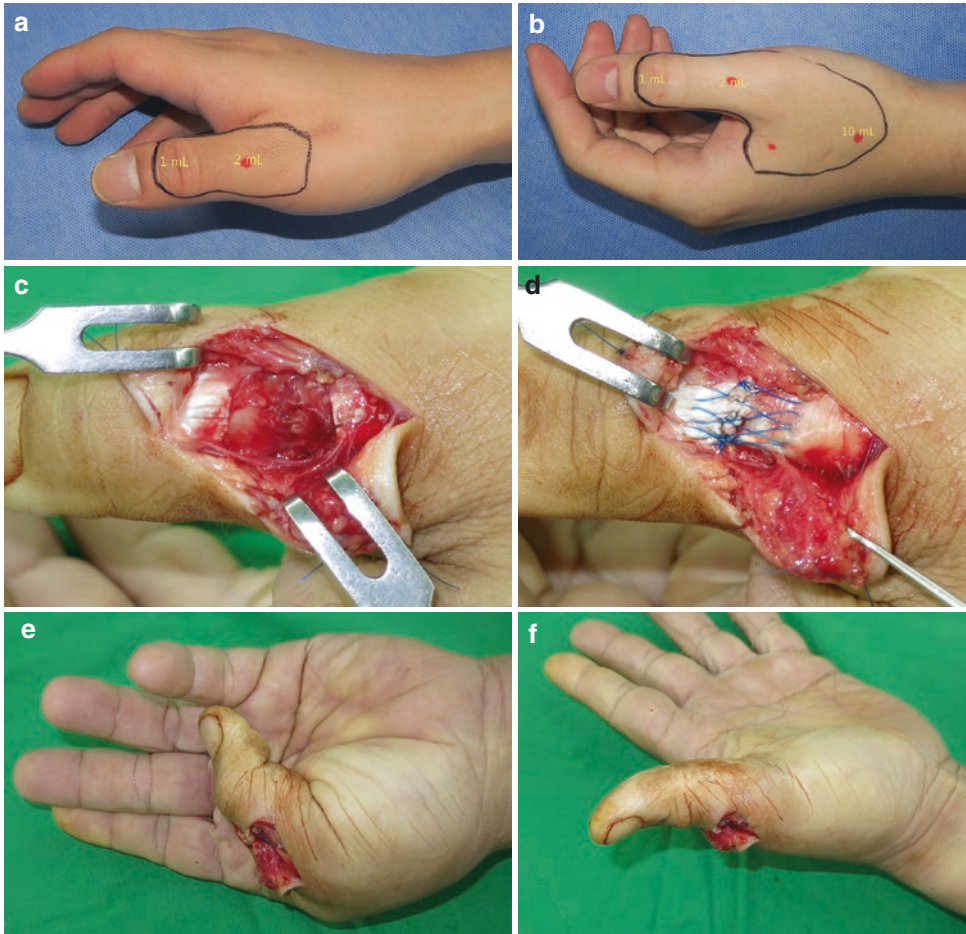
gone (3–5 days). Initiate up to half a fist of true active movement (not place and hold) from day 4 or 5. In the initial first to second week, patients keep the active flexion within only one-third of the range of motion with dynamic splint. Patients should avoid full range of active flexion in the first 2 to 3 weeks. Full range of active motion starts at 4 weeks post-repair (Fig. 12.4) (Video 12.2).

### Extensor Pollicis Longus (EPL) Tendon Repair of the Thumb

Surgeons ask the patients to flex the thumb to get the extensor to relax. The extensor pollicis longus (EPL) tendon is repaired with a six-strand core suture repair (Prolene 4–0 or 5–0 suture, Silfverskiöld epitendinous suture, or M-Becker's method). Surgeons then test the following areas:

full fist flexion and full extension after repair to verify that there is no gapping between the ends of the tendons and smooth active flexion to verify the smooth gliding of the tendon. In postoperative therapy, immobilize and elevate the hand until swelling, friction, and work of flexion are gone

(3–5 days). Patients then must comply with controlled active mobilization exercises which involve active joint extensions and limiting joint flexion with a palmar splint in the initial 1–2 weeks. Full range of active motion with dynamic splint starts at 3 weeks post-repair (Fig. 12.5).



**Fig. 12.5** (a) Dorsal thumb proximal phalanx block. When you inject 2 mL of 1% lidocaine with 1:100,000 epinephrine (buffered at a ratio 10 mL of 8.4 sodium bicarbonate) in subcutaneous fat in the red spot point. (b) When extensor pollicis longus (EPL) tendon is ruptured at more proximal area, 10 mL of anesthetic mixture of 1% lidocaine with epinephrine (1: 100,000) buffered with 10:1 8.4% bicarbonate is injected with a 27-gauge needle in just dorsal distal wrist red spot point. Fifteen minutes after the first injection, the second injection (5–10 mL) was performed subcutaneously at the more proximal dorsal area between both superficial radial sensory nerves. The final injection (2 mL) was performed immediately

after the second injection under the skin at the dorsal proximal phalanx of the thumb. (c) A 47-year-old patient hurt by a sickle ruptured the extensor pollicis longus (EPL) tendon. Thirty minutes after the local anesthesia injection, the epinephrine takes effect. Thumb flexed and extended on the table. After that, the wound was exposed. (d) This EPL shown was repaired with a Silfverskiöld epitendinous suture. (e, f) After EPL repair, the patient actively extended and flexed the thumb to perform the extension-flexion test before the skin closure. It could ensure to no gapping between the tendon ends and smooth active flexion to verify smooth gliding of the tendon

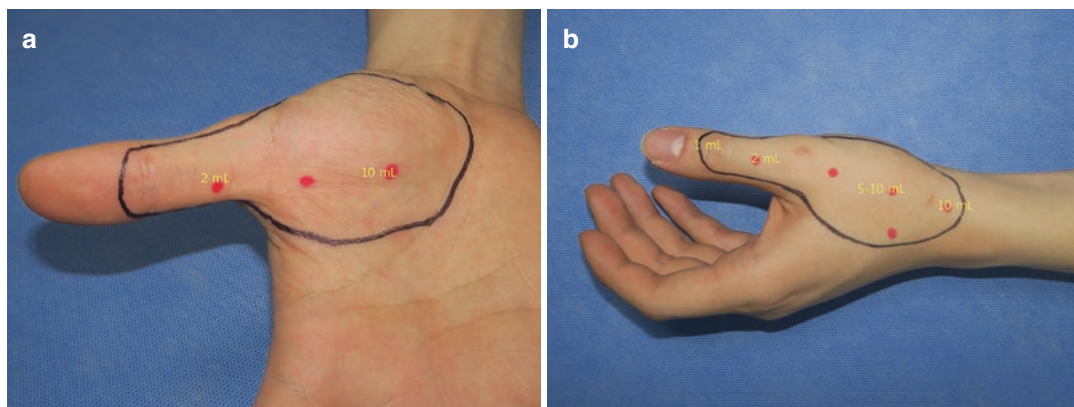
## Tenolysis of the Thumb

Tenolysis in the thumb after tendon surgery or trauma is effective in wide-awake surgery. The patient can actively move the thumb to ensure that tenolysis is adequate and that the tendon is strong enough to move the tendon. The surgeons can intraoperatively ask the patient to actively flex or extend the thumb to see the active gliding of the tendon. If the tenolysis is sufficient, the surgery is complete. If the tenolysis is insufficient, further release of scar around the tendon is necessary.

Tendons are sometimes found frayed during surgery. Active motions by the patient can help the surgeon test the strength of such tendons. If the tendon is remarkably elongated or is broken when the digits or the hand is in movement, tendon reconstruction using a tendon grafting should be considered. During active motion, the strength of the pulley can be tested as well, and whether the pulleys restrict tendon gliding can be assessed.

If the pulleys are broken during active tendon motion, important annular pulleys may need reconstruction. Restriction of the tendon gliding from the pulleys may need further release of adhesions or a pulley plasty or pulley shortening procedure.

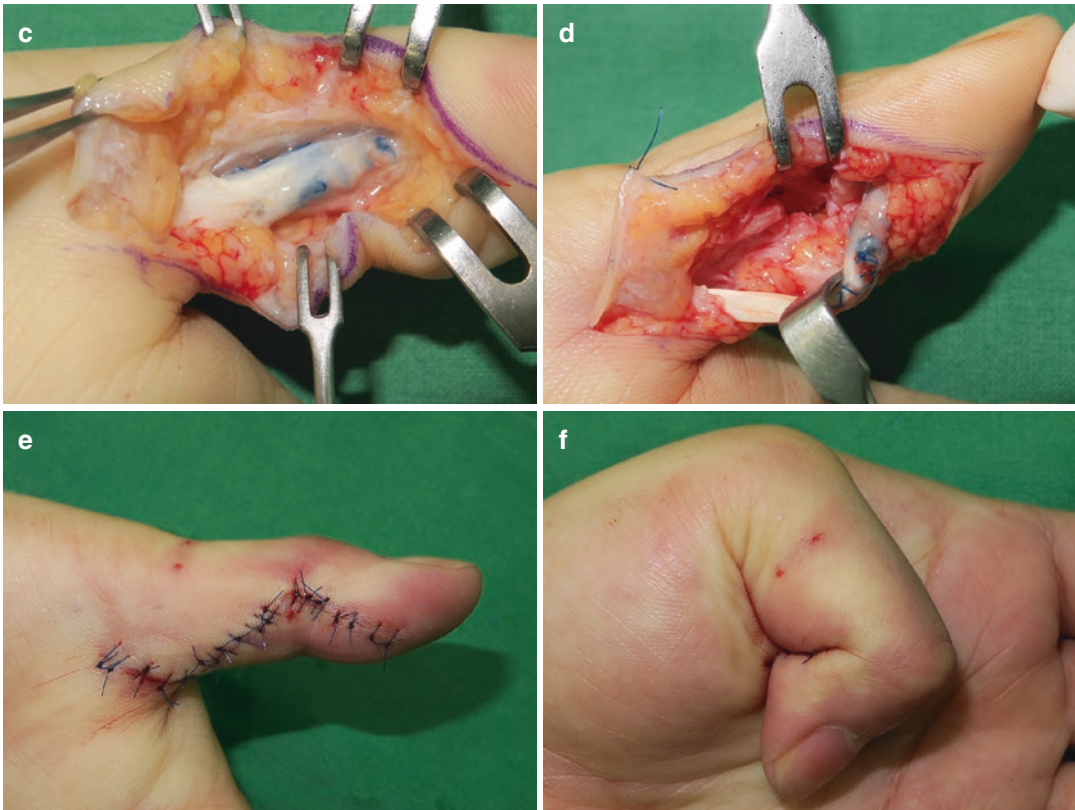
Patients can watch themselves move the thumb through a full range of motions before the skin is closed. They know that their thumb will function well once they overcome the postoperative discomfort and stiffness through putting effort in therapy. Early active motion is a key factor in the success of any tenolysis procedure and should be instituted as soon as possible. If hemostasis is not a concern and the pain is tolerable, rehabilitation in the operating room is preferable. Splinting is usually not necessary. Formal therapy continues until the patient has reached a plateau in recovery, with no improvement in active range of motion over 3 weeks [16] (Fig. 12.6) (Video 12.3).



**Fig. 12.6** (a) The flexor pollicis longus (FPL) in hypotenar may benefit from a median nerve sensory branch block of 10 mL of 1% lidocaine with 1:100,000 epinephrine and 1 mL of 8.4% sodium bicarbonate under the skin in the proximal red spot. Starting with 10 mL over the thenar eminence and 2 mL in the thumb proximal phalanx injection point just under the skin. (b) 10 mL of anesthetic mixture of 1% lidocaine with epinephrine (1:100,000) buffered with 10:1 8.4% bicarbonate is injected in just dorsal distal wrist red spot point. The second injection (5–10 mL) was performed subcutaneously at the more proximal dorsal area between both superficial radial sensory nerves. The final injection (2 mL) was per-

formed immediately after the second injection under the skin at the dorsal proximal phalanx of the thumb. (c) After a 27-year-old patient was repaired of flexor pollicis longus (FPL), the thumb was flexion contracture. Thirty minutes after the local anesthesia injection, the epinephrine takes effect. The thumb flexed and extended on the table. After that, the wound was exposed. (d) The tenolysis of FPL was done, and volar plate and joint capsule in interphalangeal joint of the thumb were released. (e, f) After that, the patient actively extended and flexed the thumb to perform the extension-flexion test. It could ensure to smooth active flexion to verify smooth gliding of the tendon





**Fig. 12.6** (continued)

### **Extensor Indicis Proprius (EIP) to Extensor Pollicis Longus (EPL) Tendon Transfer**

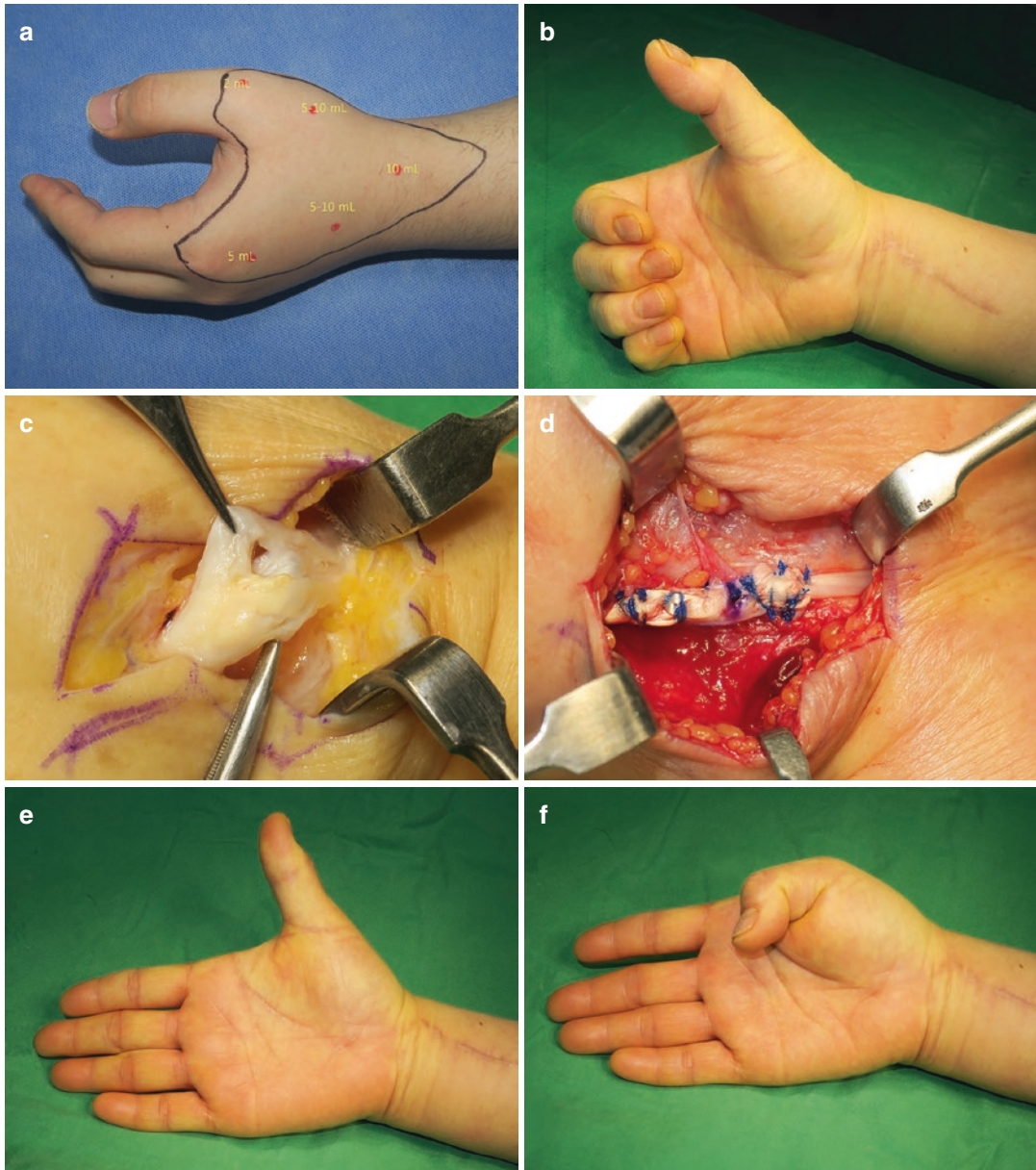
Rupture of the EPL is most frequently seen after a fracture of the radius. The transfer of the EIP is simple, synergistic, readily available, and anatomically close. Patients do not have to learn about this transfer and can cooperatively move the thumb immediately on the operating table while remaining wide awake.

Tendon transfer is best indicated during wide-awake surgery, while adjusting for the tension of the transfer has always been difficult during conventional surgery. With the patient being awake, they can move actively to determine the appropriate tension of the transfer. It is easy to make a tendon transfer too tight to too loose. Surgeons can see that four tendon transfer tension is correct by watching the patient take the thumb through a full range of motion before closing the skin [17].

The EIP and EPL tendon stumps are overlapped so that the thumb position looks good with wrist flexion and wrist extension, as is done under motor block anesthesia. Two temporary mattress sutures are placed between the two tendons. One suture may not be enough to hold the tendons with active movement. The patient is then asked to extend the thumb as if hitchhiking, to test whether the tension is tight enough. The patient is then asked to touch their little finger with their thumb, to make sure the tension is not too tight. Tension is adjusted until it is just right, and then a Pulvertaft weave is carried out [18].

Rehabilitation in patients who have already seen themselves perform a full range of motions on the operating table is greatly facilitated compared with those who have been sedated and told that the procedure will be successful after surgery. Motion with dynamic splint begins 4 days after post-repair (Fig. 12.7) (Video 12.4).





**Fig. 12.7** (a) 10 mL of anesthetic mixture of 1% lidocaine with epinephrine (1:100,000) buffered with 10:1 8.4% bicarbonate is injected in dorsal wrist red spot point. The second injection (5–10 mL) was performed subcutaneously at the more proximal dorsal area (the index and thumb) between both superficial radial sensory nerves. The final injection (2 mL) was performed immediately after the second injection under the skin at the dorsal proximal phalanx of the thumb and metacarpophalangeal joint of the

index finger. (b) A 64-year-old patient ruptured the spontaneous extensor pollicis longus (EPL) tendon. Thirty minutes after the local anesthesia injection, the epinephrine takes effect. On table, the thumb actively extended and flexed in intraoperative field. (c) The wound was exposed with tourniquet help for bloodless surgical field. (d) This EIP to EPL shown was repaired with a Pulvertaft weave. (e, f) After tendon transfer, the patient actively extended and flexed the thumb to perform the extension-flexion test

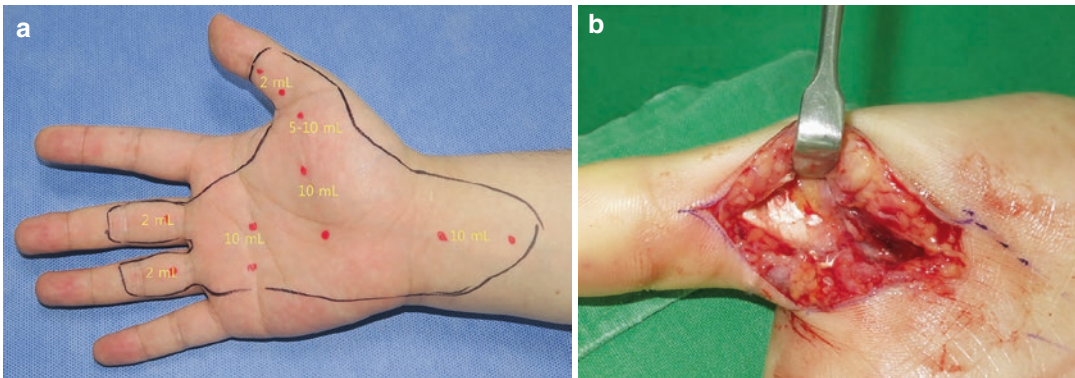
## Flexor Digitorum Superficialis (FDS) of the Long or Ring Finger to Flexor Pollicis Longus (FPL) Tendon Transfer

The flexor pollicis longus (FPL) flexes the interphalangeal (IP) joint of the thumb, and the loss of this motion impedes precision pinch activities. The flexor digitorum superficialis (FDS) tendon transfer of the ring or the long finger is a good option for FPL reconstruction under WALNAT. The harvest of the flexor digitorum superficialis (FDS) of the ring or the long finger is not difficult through small incisions, replacing the FPL entirely without supplement by a tendon graft. The procedure also requires little reeducation.

When the FPL is exposed, the normal retinacular pulley system is preserved. The FDS of the ring or the long finger is harvested after verified

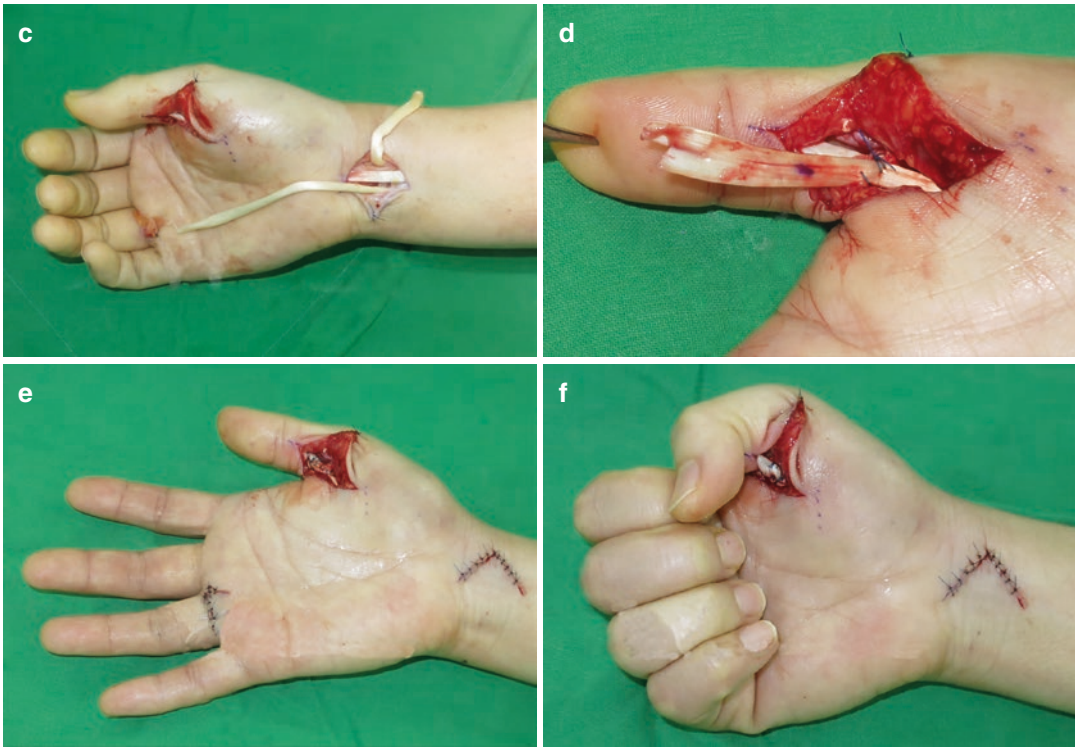
FDS movement. A third transverse incision is made at the base of the ring finger, and the FDS is cut, leaving the distal 1 cm and its insertion intact. The FDS is then withdrawn into the distal forearm wound and redirected into the thumb flexor tendon sheath. Two temporary mattress sutures are placed between the two tendons. The patient is then asked to extend the thumb as if hitchhiking, to test whether the tension is tight enough. Tension is adjusted until it is just right, and then a Pulvertaft weave is carried out.

Splinting and rehabilitation after FPL reconstructions are akin to primary repair like early active mobilization in a protective dorsal splint. It is necessary to include a dorsal splint behind the fingers as well as behind the thumb and prevent finger gripping activities, as these are followed by movement of the thumb into tight flexion over the dorsum of the index finger, which may rupture any suture of the FPL (Fig. 12.8) (Video 12.5).



**Fig. 12.8** (a) The harvested flexor digitorum superficialis (FDS) of the ring or long finger in carpal tunnel may benefit from a median nerve block of 10 mL of 1% lidocaine with 1:100,000 epinephrine and 1 mL of 8.4% sodium bicarbonate under the skin and under the distal forearm fascia in the proximal red spot. Up to 20 mL of the same solution goes in the palm, starting with 10 mL over the carpal tunnel, then 10 mL over the thenar eminence, and 2 mL in the thumb proximal phalanx injection point just under the skin. Additional injection (2 mL) was performed immediately after the second injection under the skin at proximal phalanx of the ring or long finger. (b) A 45-year-old patient ruptured the spontaneous

flexor pollicis longus (FPL). Thirty minutes after the local anesthesia injection, the epinephrine takes effect. On the table, the thumb actively extended and flexed in intraoperative field. The wound was exposed with tourniquet help for bloodless surgical field. (c) The FDS of the ring or the long finger is harvested after verified FDS movement. The FDS is then withdrawn into the distal forearm wound and redirected into the thumb flexor tendon sheath. (d) Two temporary mattress sutures are placed between the two tendons. The patient is then asked to extend the thumb as if hitchhiking, to test whether the tension is tight enough. (e, f) After tendon transfer, the patient actively extended and flexed the thumb to perform the extension-flexion test



**Fig. 12.8** (continued)

## Complications and Limitations

The white thumb after injection with epinephrine was seen when performing this procedure. If it should occur and the surgeon is uncomfortable with it, 1 mg of phentolamine (an alpha-adrenergic blocking agent introduced in 1957 as antihypertensive agent in pheochromocytoma management) can be diluted into 5–10 mL of saline solution and injected wherever epinephrine has been introduced. This is done to reverse vasoconstriction. Generally, capillary refill returns within 1 h [3] (Fig. 12.9).

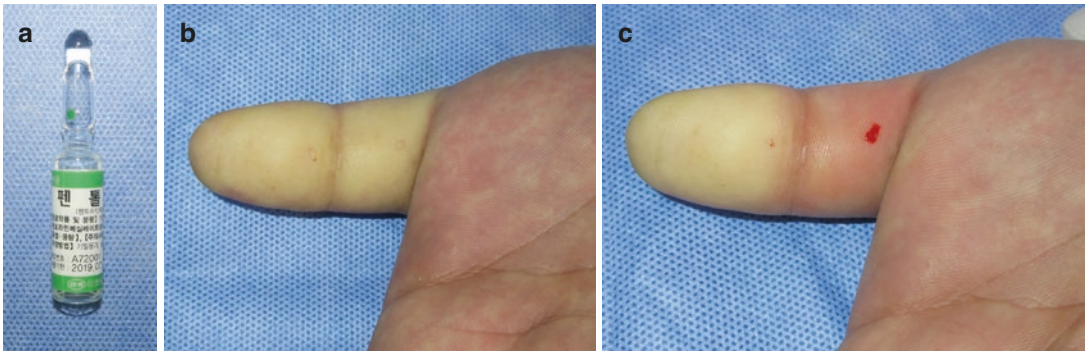
Wide-awake anesthesia has its own limitations. There is a constraint on the time in which the surgery can be carried out and a risk of enlarging the dissection and surgery areas. In addition, there is a risk of bleeding at the initial stage of surgery. These limitations can be addressed and minimized. Lidocaine's effect lasts 2 h, providing

enough time for the surgery to be carried out. In addition, the enlargement of the surgery area can be prevented by diluting the injection and carrying out the procedure. Lastly, utilizing a tourniquet at 200 mmHg during the first 20 min of the surgery can be used to combat any initial bleeding.

## Improved Results with Tendon Surgery

The ability to detect and repair gapping that can be seen during a WALANT flexor tendon repair has decreased the rupture rate [18]. In addition, full flexion and extension by a comfortable, cooperative, tourniquet-free patient allows the surgeon to vent pulleys and trim the repair so that the full range of flexion and extension of the finger can be obtained intraoperatively before the





**Fig. 12.9** (a) Phentolamine is the rescue agent for epinephrine vasoconstriction in the thumb. (b) The white thumb after injection with epinephrine was seen. (c) 1 mg of phentolamine can be diluted into 5–10 mL of saline

solution and injected wherever epinephrine has been introduced. This is done to reverse vasoconstriction. Generally, capillary refill returns within 1 h

skin is closed; this decreases the need for subsequent tenolysis [15, 16]. Obtaining an optimal tendon transfer is challenging because transfers can be either too tight or too loose. With this approach, the extensor indicis to extensor pollicis longus transfer can be adjusted during the procedure to achieve optimal results [12]. Incorporating intraoperative mobilization using “wide-awake” surgery could emerge to further improve tendon outcomes. However, good surgical approach, meticulous surgery, up-to-date physiotherapy regimens, and patient education remain the cornerstone of obtaining optimal outcomes.

## Conclusion

Patients who are wide awake are comfortable, cooperative, and educable and are able to assist the surgeon set the correct tension for the transfer. Surgeons flex and extend the finger before the skin is closed to make sure that the transfer is not too tight or too loose. In addition, remembering the fine movements of the finger during surgery assists patients when they are in postoperative hand therapy. Surgeons can also ensure the more accurate results of tendon surgery in both the intra- and postoperation stages.

In conclusion, wide-awake no tourniquet surgery, which allows tendons to actively move during surgery, greatly benefits surgeons by allowing

them to test tendon function and ensure the tendon is properly repaired before leaving the operating table.

## References

1. Lalonde DH. Reconstruction of the hand with wide awake surgery. *Clin Plast Surg*. 2011;38:761–9.
2. Lalonde DH, Martin A. Epinephrine in local anesthesia in finger and hand surgery: the case for wide-awake anesthesia. *J Am Acad Orthop Surg*. 2013;21:443–7.
3. Nodwell T, Lalonde DH. How long does it take phentolamine to reverse adrenaline-induced vasoconstriction in the finger and hand? A prospective randomized blinded study: the Dalhousie project experimental phase. *Can J Plast Surg*. 2003;11(4):187–90.
4. Lalonde DH, Bell M, Benoit P, et al. A multicenter prospective study of 3,110 consecutive cases of elective epinephrine use in the fingers and hand: the Dalhousie project clinical phase. *J Hand Surg Am*. 2005;30(5):1061–7.
5. Thomson CJ, Lalonde DH, Denkler KA, et al. A critical look at the evidence for and against elective epinephrine use in the finger. *Plast Reconstr Surg*. 2007;119(1):260–6.
6. Burk RW III, Guzman-Stein G, Vasconez LO. Lidocaine and epinephrine levels in tumescent technique liposuction. *Plast Reconstr Surg*. 1996;97(7):1379–84.
7. Lalonde DH. Dosage of local anesthesia in wide awake hand surgery. *J Hand Surg Am*. 2013;38(10):2025–8.
8. Frank SG, Lalonde DH. How acidic is the lidocaine we are injecting, and how much bicarbonate should we add? *Can J Plast Surg*. 2012;20(2):71–3.
9. Strzar AR, Leynes PG, Lalonde DH. Minimizing the pain of local anesthesia injection. *Plast Reconstr Surg*. 2013;132:675.

10. Higgins A, Lalonde DH, Bell M, et al. Avoiding flexor tendon repair rupture with intraoperative total active movement examination. *Plast Reconstr Surg.* 2010;126:941–5.
11. Lalonde DH, Kozin S. Tendon disorders of the hand. *Plast Reconstr Surg.* 2011;128:1e–14e.
12. Lalonde DH. How the wide awake approach is changing hand surgery and hand therapy: inaugural AAHS sponsored lecture at the ASHT meeting, San Diego, 2012. *J Hand Ther.* 2013;26:175–8.
13. Lalonde DH. Finger flexor tendon repair. Wide awake hand surgery. Boca Raton, FL: CRC; 2016. ISBN 9781498714792.
14. Lalonde DH. Wide awake flexor tendon repair and early mobilization in zones 1 and 2. In: Bo Tang J, Lee SK, eds. *Hand clinics tendon repair and reconstruction.* *Hand Clin.* 2013;29(2):207–13.
15. Tang JB. Wide-awake primary flexor tendon repair, tenolysis, and tendon transfer. *Clin Orthop Surg.* 2015;7(3):275–81.
16. Alba CD, LaStayo P. Postoperative management of functionally restrictive muscular adherence, a corollary to surgical tenolysis: a case report. *J Hand Ther.* 2001;14:43–50.
17. Lalonde DH. Wide-awake extensor Indicis Proprius to extensor Pollicis longus tendon transfer. *J Hand Surg Am.* 2014;39(11):2297–9.
18. Bezuhly M, Sparkes GL, Higgins A, et al. Immediate thumb extension following extensor indicis proprius to extensor pollicis longus tendon transfer using the wide awake approach. *Plast Reconstr Surg.* 2007;119(5):1507–12.