MEDICAL SCIENCE MONITOR

CLINICAL RESEARCH

e-ISSN 1643-3750
© Med Sci Monit, 2017; 23: 5034-5040
DOI: 10.12659/MSM.904676

Received: 2017.04.04
Accepted: 2017.05.25
Published: 2017.10.22

The Safety of Percutaneous Trigger Digit Release Increased by Neurovascular Displacement with Local Hydraulic Dilatation: An Anatomical and Clinical Study

Authors' Contribution:
Study Design A
Data Collection B
Statistical Analysis C
Data Interpretation D
Manuscript Preparation E
Literature Search F
Funds Collection G

ABCDEFG 1,2 **Honggang Wang***
ABCG 3 **Ping Wang***
BDEF 1 **Obioma Amajoyi**
CE 4 **Clark J. Chen**
ADEG 1,4 **Gary Y. Chen**

1 Department of Orthopedics, California Hospital Medical Center, Los Angeles, CA, U.S.A.
2 Department of Orthopedic and Microsurgery, The First Affiliated Hospital of Sun Yat-sen University, Guangzhou, Guangdong, P.R. China
3 Department of Medical Ultrasonic, The Third Affiliated Hospital of Sun Yat-sen University, Guangzhou, Guangdong, P.R. China
4 University of California Los Angeles, Los Angeles, CA, U.S.A.

* These authors are the first authors of this article and contributed equally to this work

Corresponding Author: Gary Y. Chen, e-mail: garychenmd@yahoo.com

Source of support: This study was supported by grants from the Science and Technology Planning Project of Guangdong Province (2016A020215046) and the Natural Science Foundation of Guangdong Province (2016A030313240)

Background: Although percutaneous trigger digit release is common, controversy exists regarding its safety. The purpose of this study was to evaluate the feasibility and safety of the neurovascular displacement by local hydraulic dilatation (LHD) during percutaneous trigger digit release.

Material/Methods: Ten cadaver hands with 50 digits were dissected in this anatomical study. The distance between bilateral neurovascular bundles in each digit was measured before LHD and after LHD. The difference between the measured data before LHD and those after LHD in the same digit was compared to assess the feasibility of the neurovascular displacement by LHD. A further 81 patients with 106 trigger digits were treated by percutaneous release with neurovascular displacement by LHD in our clinical series. All patients were followed for 12 months. During the follow-up period, the presence of any postoperative complication and patient satisfaction were recorded.

Results: In our anatomical study, there was a statistically significant difference ($p<0.05$) comparing the average distance of bilateral neurovascular bundles before LHD with that after LHD. In the current series, no complications, such as digital neurovascular injury or recurrence of trigger, were encountered. On subjective assessment, 80/81 patients (98.8%) with 105/106 digits (99.1%) were graded as satisfactory with complete resolution of symptoms by percutaneous release under LHD.

Conclusions: Based on our study anatomical and clinical results, the neurovascular displacement by LHD may be a feasible adjunctive technique that may play a role in increasing the safety of percutaneous trigger digit release.

MeSH Keywords: **Surgical Procedures, Minimally Invasive • Tendon Entrapment • Trigger Finger Disorder**

Full-text PDF: https://www.medscimonit.com/abstract/index/idArt/904676

2767 — 3 24

Background

Trigger digit (also known as "stenosing tenosynovitis) refers to a mechanical impingement of the flexor tendon in the hand. This condition can lead to restricted motion of the affected digit, and is a common cause of hand pain, discomfort, disability, and a "triggering" sensation in the hand [1]. The pathological changes are usually located at the level of the A1 pulley, which involve inflammation of the flexor tendon and thickening of its enveloping tendon sheath. These pathological changes lead to the discordance between the relative size of the flexor tendon and its tendon sheath, resulting in the inability to flex or extend the digit comfortably. Symptoms can be so pronounced that a finger or thumb can be locked in flexion or extension. When conservative treatment for trigger digit fails, surgical procedure in releasing the A1 pulley is required [2,3].

In 1958, Lorthioir [4] first described a new surgical technique for treatment of trigger digits by percutaneous release of the A1 pulley. Since then, the percutaneous techniques using various instruments and methods have been described, with good results and few complications [5–7]. Although the technique of percutaneous trigger digit release has become common in recent years, controversy exists regarding the safety of this technique. This is in part due to the inability to visualize the adjacent neurovascular structures, and concern of an incomplete release of the A1 pulley [8,9]. To combat this, some reports have utilized ultrasound guidance, specially-designed surgical instruments, and the safe surface landmarks of the A1 pulley, which can be used to prevent neurovascular bundle injuries and improve the safety and effectivity of percutaneous release technique [8–10].

Because the A1 pulley is so close to the lateral digital neurovascular bundles, the anatomical relationship may be regarded as the main cause of iatrogenic neurovascular injury during the percutaneous release. During an open A1 pulley release under local anesthesia, we have observed that the local anesthesia not only could block both digital proper nerves, but also serve to push the digital neurovascular bundle in a lateral direction away from the A1 pulley in virtue of hydraulic pressure. Thus the neurovascular displacement associated with local injection would be beneficial to the percutaneous trigger digit release, by increasing the distance of the neurovascular bundles away from the A1 pulley, and reducing the incidence of an iatrogenic injury of neurovascular bundles. The effect of digital neurovascular displacement caused by local injection is denoted as local hydraulic dilatation (LHD) in this study. We hypothesized that LHD might become a simple and effective way to reduce the inherent risk of the percutaneous trigger digit release.

We tested our hypothesis on 10 fresh frozen cadaver hands with a total of 50 digits to assess the feasibility of LHD by monitoring the changes of the distance between bilateral neurovascular bundles during the local injection. Furthermore, we report here the results of percutaneous release in 81 patients with 106 trigger digits under LHD in our clinic.

Material and Methods

Anatomical study

We dissected 10 thawed fresh frozen hands (fingers to midforearm) from nine unclaimed cadavers. There were three males and six females in this study. We researched the thumb, index, middle, ring, and little fingers of each hand, making a total of 50 digits.

First, we measured and marked the surface anatomical landmarks for the A1 pulley in the digits, using the techniques described by Wilhemi et al. [11] and Fiorini et al. [12]. The center of the proximal interphalangeal (PIP) joint crease was marked point A and the center of palmar digital crease (PDC) was marked point B. Wilhelmi et al. demonstrated that the distance from the PDC to the PIP crease was approximately equal to the distance from the PDC to the proximal edge of the A1 pulley (point C). The length of A1 pulley was reported to be approximately 10–12 mm for digits. The distal edge of the annulus of the flexor pollicis longus was exactly under the metacarpophalangeal flexion crease of the thumb, and the length of A1 pulley was approximately 7–9 mm for the thumb [13]. Thus, the surface landmarks of the A1 pulleys could be marked on the skin (Figure 1A). Another point was marked as point O. This point was designated as the midpoint of the A1 pulley, and it also served as the entry point for LHD. A needle was used to transect the A1 pulley perpendicularly to the skin at the point O. Then, the finger was dissected along its central longitudinal axis to verify whether the point O could correspond to the actual midpoint of the A1 pulley (Figure 1B). Based on aforementioned marking techniques, the predicted location of the A1 pulley on the skin was accurate and acceptable. For the measurement of the distance between bilateral neurovascular bundles, the volar skin from the palmar digital crease to the proximal edge of the A1 pulley was completely removed. Digit neurovascular bundles were dissected out by using X3.5 loupe magnification (Figure 1C). Next, the distance between bilateral neurovascular bundles was measured by using a digital caliper with a precision of 50th of a millimeter at the point O level (Figure 1D). The LHD was performed by injecting 5 mL of 0.9% normal saline into the subcutaneous tissue around the A1 pulley at the point O (Figure 1E). The decision to inject 5 mL of fluid was based on our clinical experience of safely using the same amount of local anesthetic, without any complications associated with neurovascular compression. After LHD at the point O, the distance between bilateral neurovascular bundles was measured again (Figure 1F).

Indexed in: [Current Contents/Clinical Medicine] [SCI Expanded] [ISI Alerting System] [ISI Journals Master List] [Index Medicus/MEDLINE] [EMBASE/Excerpta Medica] [Chemical Abstracts/CAS] [Index Copernicus]

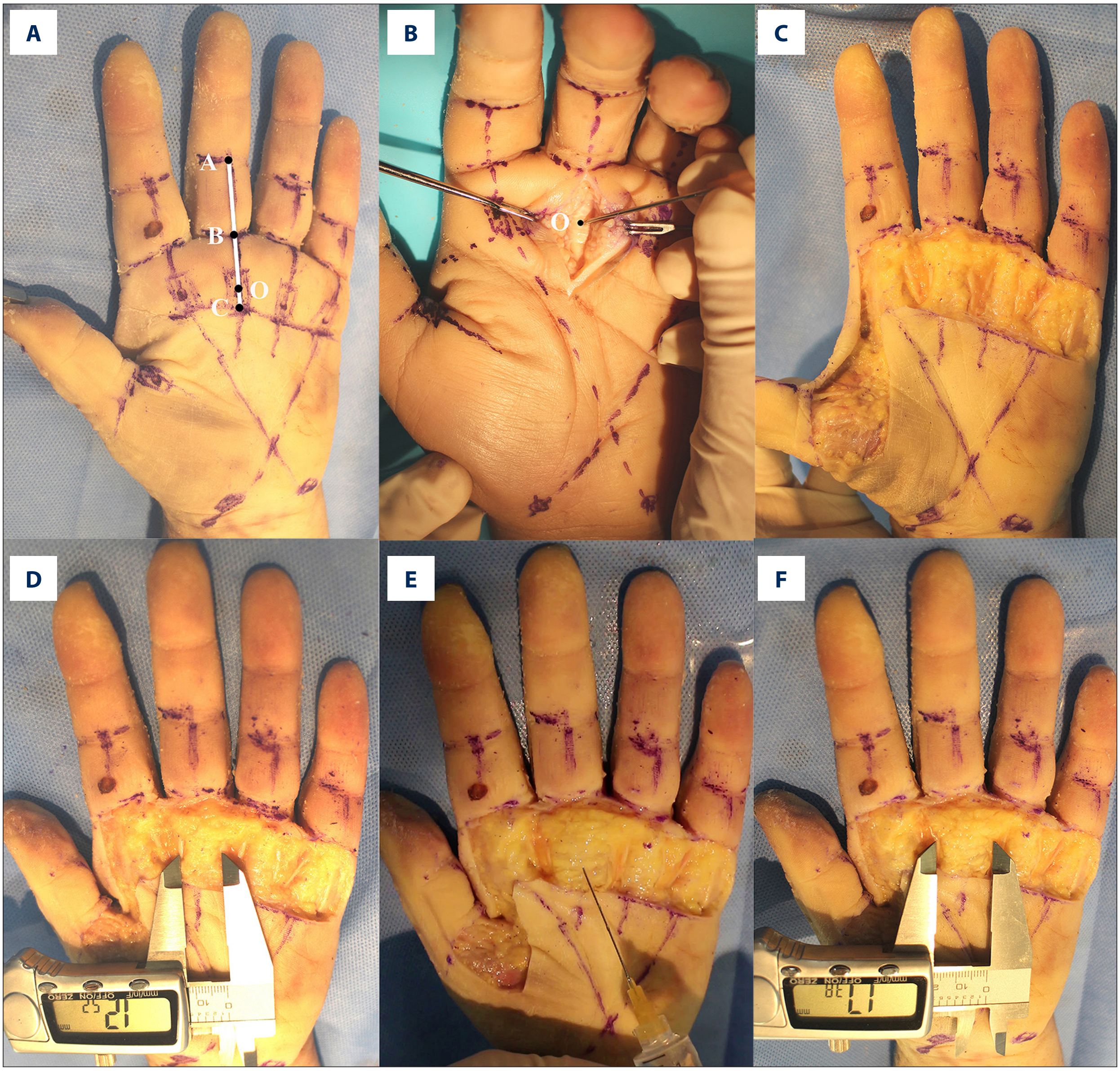

Figure 1. Illustration of the anatomical steps for measuring the distance between bilateral neurovascular bundles at the level of the A1 pulley. (**A**) The predicted location of the A1 pulley on the skin was marked. (**B**) The point O served as the midpoint of the A1 pulley was marked and verified. (**C**) The volar skin from the palmar digital crease to the proximal edge of the A1 pulley was removed and digit neurovascular bundles were dissected out completely (white arrow). (**D**) The distance between bilateral neurovascular bundles was measured by using a digital caliper before LHD. (**E**) The LHD was performed by injecting 5 mL of 0.9% normal saline to push the bilateral neurovascular bundles away from the A1 pulley. (**F**) The distance between bilateral neurovascular bundles was measured after LHD.

The average distance between bilateral neurovascular bundles of digits was expressed as the mean ±SD. In this study, we used a paired *t*-test to compare the differences between the distances of bilateral neurovascular bundles before LHD and after LHD in the same digit. Values were considered statistically significant at a value of $p<0.05$.

Clinical series

During the period from January 2015 to December 2015, a total of 81 patients with 106 trigger digits were treated by percutaneous release under LHD. There were 30 males and 51 females with a mean age of 53.8 years (range, 31 to 71 years). Twenty-eight patients had diabetes mellitus and 15 patients had previously undergone a carpal tunnel release in the same

Indexed in: [Current Contents/Clinical Medicine] [SCI Expanded] [ISI Alerting System] [ISI Journals Master List] [Index Medicus/MEDLINE] [EMBASE/Excerpta Medica] [Chemical Abstracts/CAS] [Index Copernicus]

hand. The distribution of the involved digits were 23 thumbs (21.7%), 12 index fingers (11.3%), 35 middle fingers (33.0%), 32 ring fingers (30.2%), and four little fingers (3.8%). A single digit was involved in 58 patients, two digits in 21 patients, and three digits in two patients. The mean duration of symptoms prior to percutaneous release was 6.8 months (range, 3 to 24 months). The digits were graded according to Eastwood's classification [6], which was based on the degree of severity of the trigger digits. In grade 0, there was mild crepitus in a nontriggering digit. In grade I, there was uneven movement of the digit. In grade II, there was clicking of the digit without locking. In grade III, there was locking of the digit that was either actively or passively correctable. In grade IV, the digit was locked in a fixed position upon presentation. There were 76 digits (71.7%) classified as grade III, and 30 digits (28.3%) digits as grade IV.

Patients included in this series were those who had grade III triggering, grade IV triggering, or those who had persistent symptoms after a minimum of three months of conservative treatment. Patients with congenital trigger finger, or severe trauma of the ipsilateral forearm were excluded. The ethical committee of our institution approved the treatment protocol. A written informed consent was obtained from all the patients before surgery. The percutaneous technique applied with an 18-gauge needle was similar to that described by other authors [5,6,14]. Before the surgical intervention, the region around the A1 pulley was infiltrated by the 5 mL of local anesthetic consisting of 1% lidocaine mixed with 0.25% Marcaine (50: 50), which served the roles of local anesthesia and LHD. The potential role of LHD was to reduce the incidence of digital neurovascular injury during the percutaneous release of the A1 pulley. During the procedure, we found it useful to attach the needle to a syringe, to facilitate easier handling and better directional control of the needles bevel tip. A swiping movement of the needle was used to cut the A1 pulley. When the disappearance of the grating sensation indicated adequate release of the A1 pulley, the patient was be asked to flex and extend the digit to confirm that the triggering had ceased.

After the procedure, a small compressive dressing was applied. An oral analgesic prescribed was necessary for pain control after operative treatment. The second day after surgery, the dressing could be removed. Normal daily activities were immediately allowed if the patient could tolerate them. These patients were followed-up weekly for a month, and monthly for 12 months. During the follow-up, the presence of persistent pain, infection, flexor tendon injury, neurovascular injury, recurrence, and patient satisfaction were evaluated. All cases were done by a single surgeon.

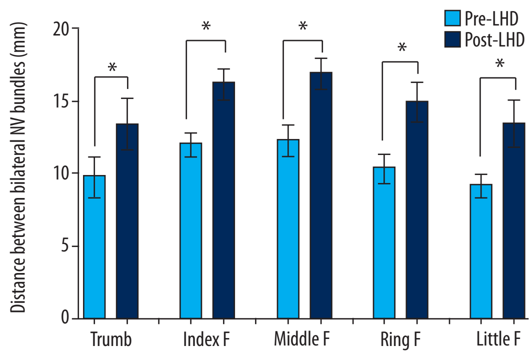

Figure 2. The graph showing the statistically significant difference by comparing the average distance between bilateral neurovascular bundles before LHD with that after LHD. Pre-LHD – before local hydraulic dilatation; post-LHD – after local hydraulic dilatation; NV bundles – neurovascular bundles; F – finger; * $p<0.05$, n=10.

Results

Anatomic results

Before LHD, the average distance between bilateral neurovascular bundles was 9.71±1.37 mm in the thumbs, 12.00±0.86 mm in the index fingers, 12.26±1.08 mm in the middle fingers, 10.37±0.90 mm in the ring fingers, and 9.19±0.80 in the little fingers, respectively. After LHD, the corresponding average distance was increased to 13.36±1.76 mm in the thumbs, 16.20±1.08 mm in the index fingers, 16.86±0.95 mm in the middle fingers, 14.90±1.32 mm in the ring fingers, and 13.34±1.66 in the little fingers, respectively. Comparing the measurement data of the same digit before LHD with those after LHD, there was statistically significant difference ($p<0.05$; Figure 2).

Clinical results

Of the 106 digits treated, there was complete resolution of symptoms in 98 digits when seen one week after operation (Figure 3). Seven digits had residual tenderness at the site of release during the first follow-up, which disappeared after four weeks of physical therapy. One patient with a locked trigger thumb had persistent triggering after percutaneous release. Of note, she was an overweight female with an 8-year history of type-2 diabetes mellitus. She subsequently underwent open surgical release, and achieved a complete resolution of triggering without any complication.

Major complications, such as digital vascular compression, digital nerve injury, flexor tendon disruption, infection of the tendon sheath, or recurrence of trigger were not encountered in this clinical series. On subjective assessment, 80/81 patients

Indexed in: [Current Contents/Clinical Medicine] [SCI Expanded] [ISI Alerting System] [ISI Journals Master List] [Index Medicus/MEDLINE] [EMBASE/Excerpta Medica] [Chemical Abstracts/CAS] [Index Copernicus]

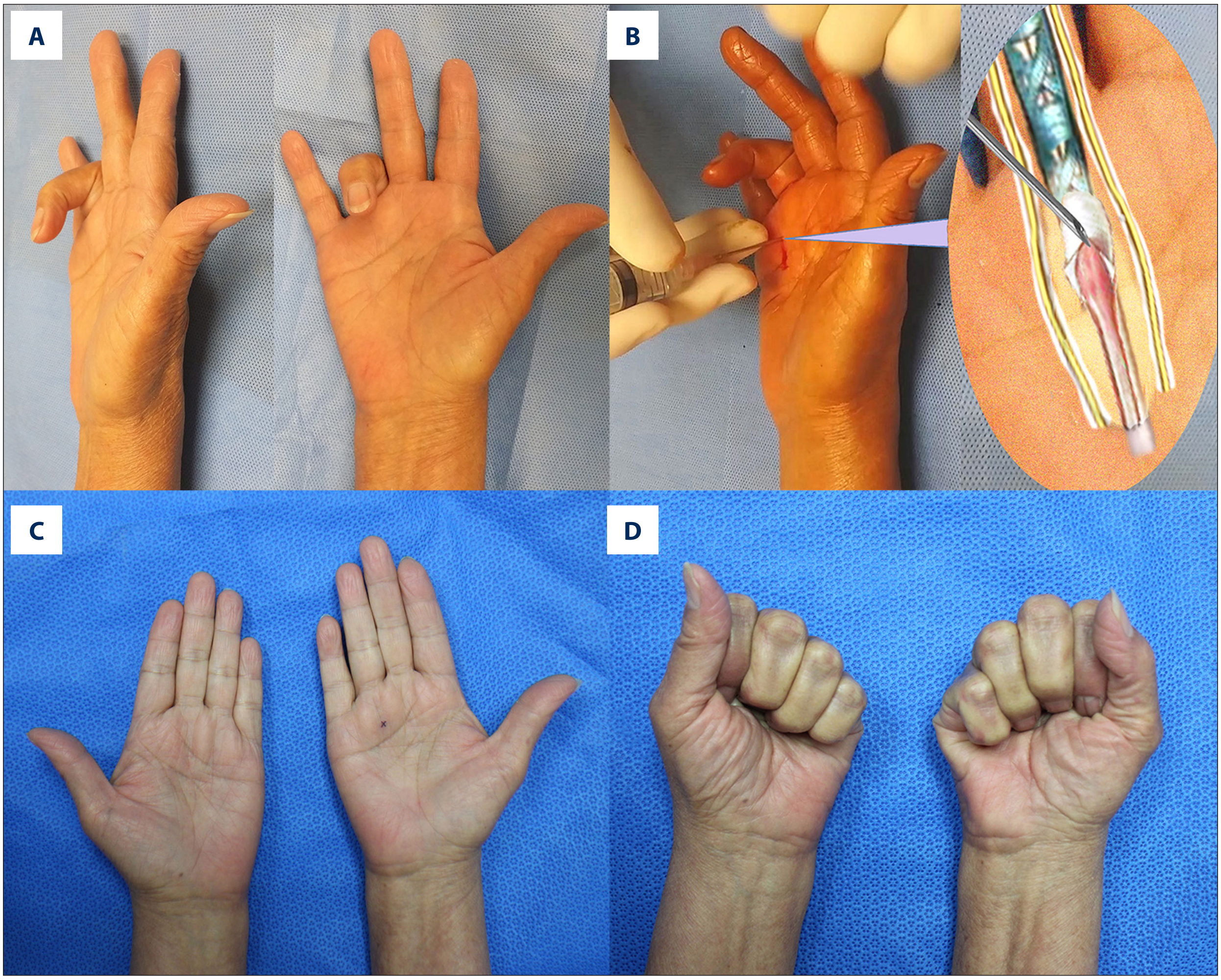

Figure 3. A 70-year-old female with a 3-month history of right ring finger locked, achieved a complete resolution of symptoms by percutaneous release under LHD. (**A**) The right ring finger locked in flexion position (grade IV). (**B**) The percutaneous release applied with an 18-gauge needle under LHD. (**C, D**) The clinical symptoms resolved completely without any complication when followed one week after percutaneous release.

(98.8%) with 105/106 digits (99.1%) were graded as satisfactory with complete resolution of symptoms by percutaneous release under LHD. The one patient who required open surgical release was graded as unsatisfactory.

Discussion

The percutaneous release of trigger digits has gained popularity recently, and a number of studies have evaluated the safety and efficacy of the minimally invasive technique [5,6,15–17]. The outcomes of open versus percutaneous release for the treatment of 100 trigger digits were reported by Gilberts et al. [15] in a prospective randomized trial. Gilberts et al. showed that both release techniques were equally effective, and no major complications, including digital nerve injury, were noted in the study groups. The advantages of percutaneous technique were reported as simple, quick, and less painful, thus, rehabilitation for the percutaneous group was easier when compared to those who underwent the open surgical release technique. Another randomized clinical trial by Sato et al. [16] stated that the therapeutic effect of the percutaneous and open surgery methods was similar and that surgical intervention proved superior to the conservative corticosteroid method regarding success and relapse rates. Therefore, some authors advocate the percutaneous trigger digit release based on the advantages as followed [5,6,15–18]: 1) it can be performed under local anesthesia without a tourniquet, 2) it is minimally invasive technique without postoperative scar, 3) it takes less operative time and recovery time, 4) it produces less postoperative pain, 5) it allows patients to return to work and activities of daily living sooner, and 6) it is significantly less expensive.

Indexed in: [Current Contents/Clinical Medicine] [SCI Expanded] [ISI Alerting System] [ISI Journals Master List] [Index Medicus/MEDLINE] [EMBASE/Excerpta Medica] [Chemical Abstracts/CAS] [Index Copernicus]

Despite the high success rate of percutaneous trigger digit release in the clinical setting, the incidence of complications is still a main area of debate. Because the anatomical distance between the A1 pulley and the digital neurovascular bundles is so short, the major concern with percutaneous release is digital nerve injury. There have been some complications reported, which were related to surgical release of the trigger finger. Eastwood et al. [6] used a 21-gauge hypodermic needle on 35 trigger digits and relieved symptoms in 94% without complications. Although Eastwood et al. released three thumbs in their study, they noted that the obliquity and volar position of the neurovascular bundles in the thumb required particular caution. Carrozella et al. [19] reported that the radial digital nerve injury was encountered in four cases after surgical release of trigger thumb. They noted that the nerve transection injury was inevitably involved if the digital nerve was trapped between the knife blade and the sesamoid. Gilberts et al. [20] retrospectively reported the long-term follow-up results of 336 digits after surgical release procedure, including 70 open released trigger digits and 266 percutaneously released trigger digits. There were three patients who suffered sensory loss on the radial side of the thumb in the percutaneous release group. Guler et al. [21] also reported two cases with iatrogenic digital nerve injury seen in the blinded percutaneous release group. Although it was not found to be statistically significant, they believed that blinded percutaneous trigger thumb release would increase the risk of neurovascular injury. Sreedharan et al. [22] reported that there was one case of radial digital neuroma formation in middle finger after trigger release.

There are several cadaveric studies in which the anatomical distance between the digital nerves and the A1 pulley were measured in order to evaluate the risk of the iatrogenic nerve injury during percutaneous release [7,9,23,24]. Pope et al. [23] noted that the distance between the digital nerve and the needle puncture site in the index finger and thumb was within 2 to 3 mm during percutaneous release in 25 cadaveric palms. They concluded that percutaneous release was potentially hazardous in trigger thumb or index finger. Buldu et al. [9] used 20 thumbs of 10 fresh cadavers to measure the distance between the digital nerves and the A1 pulley. They reported that the mean distance from the radial digital nerve to the A1 pulley is 3.4 mm at the proximal margin level of the A1 pulley. But the radial digital neurovascular bundle crosses the flexor tendon sheath at the proximal margin of the A1 pulley, so any sharp dissection proximal to the margin of the A1 pulley may cause digital nerve injury. Schramm et al. [7] used six fresh-frozen cadaveric hands to perform percutaneous release of the A1 pulley before freezing all specimens. Then they performed cross-sections at the level of the A1 pulley and measured the distance between needle tracts to the neurovascular bundle. They found that the closest distance was 2.7 mm from needle tracts to the neurovascular bundle. Based on their anatomic results, the authors suggested caution when releasing the index finger, little finger, or thumb to avoid injury to a digital nerve, respectively.

In our anatomic study, we found that the average distance between bilateral neurovascular bundles could be increased about 4 mm in all fingers and thumbs by using the local hydraulic dilatation method with 5 mL of 0.9% normal saline. The difference of the anatomic distances was statistically significant, comparing the measurement data of each digit before and after LHD. These results suggest that the LHD is a simple, effective, and feasible technique for increasing the distance between the digital nerves and the A1 pulley, thereby decreasing the possibility of nerve injury complications. During our clinical series, there were 81 patients with 106 trigger digits treated by the percutaneous release, accompanying with LHD of 5 mL local anesthetics. There were no complications involving injury to the adjacent digital neurovascular structures in this case series, which indicated that the pressure produced by the LHD was acceptable and safe for all patients treated. All patients had complete resolution of their triggering symptoms with no serious complications during the study period. The patient satisfaction rate after percutaneous release with LHD was 98.8%, except for one patient who required a subsequent open surgical release for a persistent trigger thumb.

Conclusions

Based on our anatomical and clinical results, LHD may be a feasible adjunctive technique that may play a role in increasing the safety and efficacy of percutaneous trigger digit release.

Conflict of interests

None.

Acknowledgment

All authors thank the assistance from MicroMed Inc. in the preparation of the anatomical study.

Indexed in: [Current Contents/Clinical Medicine] [SCI Expanded] [ISI Alerting System] [ISI Journals Master List] [Index Medicus/MEDLINE] [EMBASE/Excerpta Medica] [Chemical Abstracts/CAS] [Index Copernicus]

References:

1. Ryzewicz M, Wolf JM: Trigger digits: Principle, management, and complication. J Hand Surg, 2006; 31A: 135–46
2. Becker SJ, Braun Y, Janssen SJ et al: Early patient satisfaction with different treatment pathways for trigger finger and thumb. J Hand Microsurg, 2015; 7(2): 283–93
3. Giugale JM, Fowler JR: Trigger finger: Adult and pediatric treatment strategies. Orthop Clin North Am, 2015; 46(4): 561–69
4. Lorthioir J: Surgical treatment of trigger finger by a subcutaneous method. J Bone Joint Surg Am, 1958; 40-A(4): 793–95
5. Diab RA: Percutaneous release of trigger finger. J Orthop Surg (Hong Kong), 2015; 23(2): 241–42
6. Eastwood DM, Gupta KJ, Johnson DP: Percutaneous release of the trigger finger: an office procedure. J Hand Surg Am, 1992;17: 114–17
7. Schramm JM, Nguyen M, Wongworawat MD: The safety of percutaneous trigger finger release. Hand (NY), 2008; 3: 44–46
8. Gulabi D, Cecen GS, Bekler HI et al: A study of 60 patients with percutaneous trigger finger releases: Clinical and ultrasonographic findings. J Hand Surg Eur Vol, 2014; 39(7): 699–703
9. Buldu H, Cepel S, Ki N et al: References to avoid complications in releases of the trigger thumb: A cadaveric study. Acta Orthop Traumatol Turc, 2006; 40(4): 311–14
10. Huang HK, Wang JP, Wang ST et al: Outcomes and complications after percutaneous release for trigger digits in diabetic and non-diabetic patients. J Hand Surg Eur Vol, 2015;40(7): 735–39
11. Wilhelmi BJ, Snyder NT, Verbesey JE et al: Trigger finger release with hand surface landmark ratios: An anatomic and clinical study. Plast Reconstr Surg, 2001; 108: 908–15
12. Fiorini HJ, Santos JB, Hirakawa CK et al: Anatomical study of the A1 pulley: Length and location by means of cutaneous landmarks on the palmar surface. J Hand Surg, 2011; 36A: 464–68
13. Zhang C, Tang T, Fu T: A technique for accurately marking the A1 pulley on the skin. J Hand Surg Br, 2012; 37(9): 888–89
14. Mishra SR, Gaur AK, Choudhary MM et al: Percutaneous A1 pulley release by the tip of a 20-g hypodermic needle before open surgical procedure in trigger finger management. Tech Hand Up Extrem Surg, 2013; 17(2): 112–15
15. Gilberts EC, Beekman WH, Stevens HJ et al: Prospective randomized trial of open versus percutaneous surgery for trigger digits. J Hand Surg Am, 2001; 26(3): 497–500
16. Sato ES, Gomes Dos Santos JB, Belloti JC et al: Treatment of trigger finger: Randomized clinical trial comparing the methods of corticosteroid injection, percutaneous release and open surgery. Rheumatology, 2012; 51(1): 93–99
17. Liu YP, Du YY, Wang MM et al: Small longitudinal S incision and page turning style of annular ligament partial resection to treat stenosing tenosynovitis of thumb flexor tendon. Med Sci Monit, 2014; 20: 683-87
18. Uçar BY: Percutaneous surgery: A safe procedure for trigger finger? N Am J Med Sci, 2012; 4(9): 401–3
19. Carrozzella J, Stern PJ, Von Kuster LC: Transection of radial digital nerve of the thumb during trigger release. J Hand Surg, 1989; 14A: 198–200
20. Gilberts EC, Wereldsma JC: Long-term results of percutaneous and open surgery for trigger fingers and thumbs. Int Surg, 2002; 87(1): 48–52
21. Guler F, Kose O, Ercan EC et al: Open versus percutaneous release for the treatment of trigger thumb. Orthopedics, 2013; 36(10): e1290–94
22. Sreedharan S, Teoh LC, Chew WY: Neuroma of the radial digital nerve of the middle finger following trigger release. Hand Surg, 2011; 16(1): 95–97
23. Pope DF, Wolfe SW: Safety and efficacy of percutaneous trigger finger release. J Hand Surg Am, 1995; 20(2): 280–83
24. Hazani R, Elston J, Wilhelmi BJ: Transverse anatomic landmarks for the A1 pulley of the thumb. Hand (NY), 2011; 6(4): 416–19

Indexed in: [Current Contents/Clinical Medicine] [SCI Expanded] [ISI Alerting System] [ISI Journals Master List] [Index Medicus/MEDLINE] [EMBASE/Excerpta Medica] [Chemical Abstracts/CAS] [Index Copernicus]