Original Article

Ultrasound-Guided Percutaneous A1 Pulley Release: Needle Technique

Norarit Luanchumroen MD[1]

[1] Rehabilitation Medicine Division, and Academic Affairs Division, Nopparat Rajathanee Hospital, Department of Medical Services, Ministry of Public Health, Bangkok, Thailand

Background: Ultrasound [US]-guided percutaneous annular [A1] pulley release using needle is a minimal invasive surgery that enables early functional recovery with low complication rates for trigger finger [TF] treatment.

Objective: To evaluate the results of such surgical technique for TF treatment in Thais.

Materials and Methods: The present study was a single center, prospective cohort study. Patients age 20 years and older diagnosed as grade II TF or higher for at least four months and unresponsive to conservative treatment were included in the study. The patients having chronic diseases or rheumatoid arthritis, previous TF surgery, pregnant, or bleeding risks were excluded. US-guided percutaneous A1 pulley release using needle were performed for TF treatment. TF recovery, pain, use of analgesic medications, return time to normal activity, cosmetic, and overall satisfaction using 10-cm visual analog scale were assessed one week post-operation. Surgical complications were followed-up for six months.

Results: Thirty-nine fingers from 33 patients received US-guided percutaneous A1 pulley release using needle were included in analysis. Mean operative time (± SD) was 6.17±1.70 minutes. Median (IQR) of post-operative pain durations, use of analgesic medications, and recovering time to normal activity were 1 (0, 2), 0.5 (0.5, 1), and 2 (1, 2) days, respectively. Means of patient satisfaction scores for wound appearance and overall treatment were 9.87 and 9.61, respectively. Only one patient had incomplete release. No severe complication was observed.

Conclusion: US-guided percutaneous A1 pulley release with needle technique was an effective treatment for TF without severe complication and high levels of overall satisfaction.

Keywords: Ultrasound-guided, Percutaneous release, Trigger finger, A1 pulley

J Med Assoc Thai 2018; 101 (11): 1543-9
Website: http://www.jmatonline.com

Trigger finger [TF] is one of the most common causes of hand pain and disability, frequently occurring in people aged 40 to 60 years and are more common in women than men[1-3]. In TF, there are thickening of the flexor tendon and hypertrophy of the retinacular sheath, resulting in restriction of the motion of the flexor tendon. This sheath normally forms a pulley system consisting of a series of annular and cruciform pulleys in each digit that serve to maximize efficiency of flexor tendon's function. The first annular [A1] pulley is the most often affected pulley in TFs[3-5]. The exact cause of TF is unknown. However, it was found that repetitive microtrauma, patients with diabetic mellitus, hypothyroidism, rheumatoid arthritis, renal disease, and amyloidosis have higher risk for TF development[1-3].

Percutaneous A1 pulley release was first performed and described by Lorthioir in 1958[6]. Since then, there were many studies of percutaneous A1 pulley release both needle and hook knife techniques reported that there were no differences in treatment efficacy between percutaneous and open techniques. However, percutaneous technique still has risks of neurovascular iatrogenic injury or incomplete A1 pulley release[7-13]. Current use of musculoskeletal diagnostic ultrasound [US] imaging for the assessment of complex anatomy and pathology disorders markedly increased due to the rapid development of US technology both hardware and software. High-frequency US probe, provide clear visualization of A1 pulley[14]. Figures 1a and 1b present the images of flexor tendon and A1 pulley from high-frequency US probe in short and long axis, respectively.

A study to evaluate the safety and efficacy of US-guided percutaneous TF release [PTFR] showed that US-guided PTFR still had been complicated by flexor

Correspondence to:

Luanchumroen N. Rehabilitation Medicine Division, and Academic Affairs Division, Nopparat Rajathanee Hospital, Department of Medical Services, Ministry of Public Health, Bangkok 10230, Thailand.
Phone: +66-81-4430709
Email: tonnorarit@yahoo.com

How to cite this article: Luanchumroen N. Ultrasound-guided percutaneous A1 pulley release: needle technique. J Med Assoc Thai 2018;101: 1543-9.

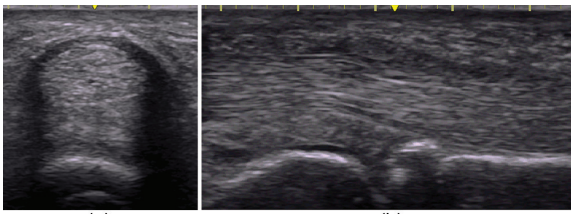

Figure 1. Ultrasound images of flexor tendon and A1 pulley in (a) short and (b) long axis.

tendon lacerations, potential injury to neurovascular bundles, and incomplete division of the A1 pulleys. However, they concluded that use of US allows visualization of the pulleys, tendons, the neurovascular bundles, and the operating needle, which may result in improved safety[15]. Another study of percutaneous A1 pulley release performed using needle and hook knife techniques in an unembalmed cadaveric model showed no neurovascular or A2 pulley injury occurred in any digit, regardless of technique and concluded that US-guided percutaneous A1 pulley releases can be performed safely[16]. Rojo-Manaute et al studied to define the safety of US-guided PTFR in cadavers (100 fingers of 10 cadavers) and agreed that US-guided PTFR can be performed safely in all fingers[17]. They also prospectively studied US-guided PTFR in 48 digits of 48 TF patients with 3-mm hook knife as cutting device. The success rate was 100% without recurrence. However, their US-guided PTFR was complicated[18]. US-guided PTFR with needle is an option for treatment of TF. Rajeswaran et al evaluated US-guided PTFR using a standard 19-gauge hypodermic needle bent at two points as the cutting device in treatment of 35 TFs. There were no complications at 12-weeks and 6-months follow-up and all patients demonstrated improvement in their triggering with complete resolution in 32 digits (91%). They concluded that US-guided PTFR using needle as the cutting device was safe and could be used to provide definitive management for TF allowing the procedure to be performed in a variety of clinical settings[19]. Previous studies of US-guided PTFR provided the differences of complication and incomplete release rates[15,16,18,19]. The wavelength, frequency, manufacturers of US were also different among studies. The new US technologies have significantly improved image resolution over the past decade. In addition, these studies did not mention about time to complete resolution, recovering time to full hand function, or pain from the surgical techniques. Therefore, the present study aimed to access the outcome of US-guided PTFR using needle as the cutting device in term of treatment efficacy, recovering time, patient-reported treatment, and cosmetic satisfaction.

Materials and Methods

Study design

The present article was a single-center prospective cohort study to evaluate the results of US-guided A1 pulley release with needle technique for TF treatment in Thai patients. This procedure was performed by the author having two-years experience of musculoskeletal ultrasonography and US-guided intervention in musculoskeletal and spinal pain. The study was approved by the Ethics Committee of Nopparat Rajathanee Hospital prior to the commencement of the study.

The present study was carried out among adulthood TF patients (age equal or more than 20 years) attending the Outpatient Unit of Rehabilitation Medicine Division, Nopparat Rajathanee Hospital between January and August 2016. All TF grade II or higher patients with persisting symptoms longer than four months, unresponsive to conservative treatment, which consisted of corticosteroid injection, medications, splinting, and/or physical therapy, who attended the outpatient clinic were invited to participate in the study. The patients who had underlying disease of rheumatoid arthritis, previous TF surgery of the same trigger digit(s), pregnant women (ethics committee mandated), bleeding risks, and refusal to receive the surgical treatment were excluded. The eligible patients received US-guided percutaneous A1 pulley release with needle technique for TF treatment. Forty-fingers was the sample size planned. After the operation, the patients were followed-up for one week at outpatient clinic and by phone interview at six months to collect the treatment outcomes, including treatment and cosmetic satisfaction.

Data collection and operative outcomes

Patients' baseline demographic characteristics, i.e., gender, age, hand dominance, digit involved, and duration of TF were collected. The operative time (from the start of local anesthesia to the end of operation) and disappearance of triggering symptom from TF were observed during the procedure. A one-week follow up after operation was scheduled to collect resolution of TF, length of analgesic medication using (time from post-operation to the last dose of analgesic medication), post-operative pain duration (time from

post-operation to recovery from pain), recovering time to normal activities (days), and satisfaction with wound appearance and overall treatment using 10-cm visual analogue scale [VAS]. Treatment complications and TF recurrence were collected by interviewing and observation at week 1 visit and by phone interviewed six months after the operation.

US-guided percutaneous A1 pulley release with needle technique

The patient was placed in supine position. The affected arm was abducted by 90° and positioned palm up. Ultrasonography was performed to identify A1 pulley, neurovascular bundles, and dynamic study of triggering prior to operation.

LOGIQ™ e Premium US machine with an 18 MHz hockey stick transducer manufactured by GE healthcare (see Figure 2) was used to obtain US images throughout the study. Before starting the procedure, 18-guage 1.5-inch needle was manually curved by needle holder to about 90° angle and its bevel faced laterally.

Prior to A1 pulley release, the surgical skin surface was cleaned with 70% ethyl alcohol, applied sterile ultrasonic gel on the affected finger and surrounding area, hockey stick probe wrapped with a sterile covering (Tegaderm®, size 10×12 centimeters) was placed in the longitudinal plane of long flexor tendon at A1 pulley. The 1% lidocaine with adrenaline as local anesthesia were injected by 27-gauge 1-inch needle into proximal digital crease, point to proximal direction under real time ultrasonic visualization for index, middle, ring, little fingers, whereas, for thumb, was injected at 1 to 1.5 cm distal to the metacarpophalangeal crease. Local anesthetic solution was infiltrated just above A1 pulley aim not for anesthetize only but also enhance visualization of A1 pulley as well. The prepared 18-Guage needle attached with 5 ml syringe containing 0.1 to 0.2 ml of 10 mg/ml Triamcinolone Acetonide (equal with 1 to 2 mg) was inserted in the same site with local anesthesia injection site. US guiding was carefully adjusted in the longitudinal plane to make sure that the tip of the needle, A1 pulley and the flexor tendon were visible on US screen throughout the procedure (see Figure 3). The needle tip was placed at position between A1 pulley and upper border of flexor tendon on long axis view, starting from the distal edge of A1 pulley, then advance tip of needle about 0.5 to 1 mm underneath A1 pulley, then cut A1 pulley by upper sharped part of bevel, repeating the same pattern until reach proximal edge of A1 pulley. Grating sensation was observed to confirm that the A1 pulley was correctly released during the procedure (see video at www.youtube.com/watch?v=XwFj_AIzR94).

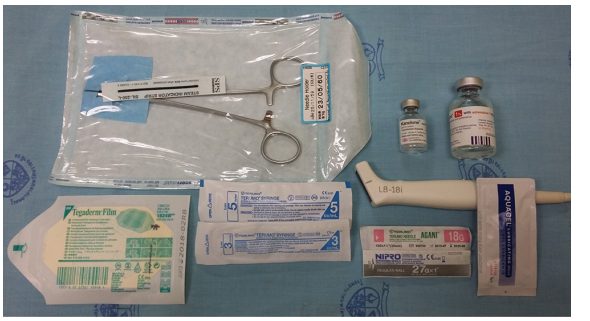

Figure 2. Materials and equipment for US-guided A1 pulley release with needle technique.

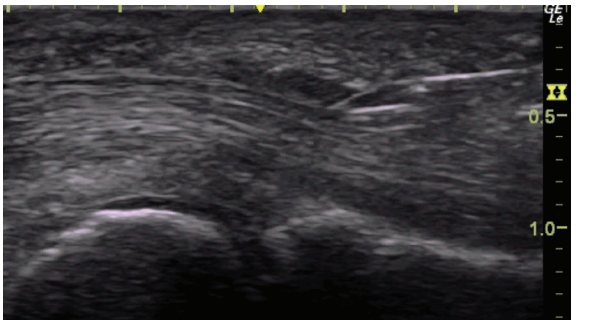

Figure 3. Ultrasound image of needle tip during US-guided A1 pulley release.

After A1 pulley was cut, the syringe filled-triamcinolone was injected at cut A1 pulley. Then, the needle was removed, and the patient was asked to flex and extend the treated finger. If the triggering was gone, the procedure was considered complete. The surgical site was covered with a water-proof adhesive dressing. The patient was instructed to self-remove the dressing at home in the next day, 24 hours after operation and advised to use the treated hand as soon as possible. Paracetamol was prescribed, and the patient was advised to take as necessary if they felt pain at the operation site. The patients were followed up one week after operation at the outpatient department, and at six months by phone interview.

Statistical analysis

Descriptive statistics, i.e., percentage, proportion, and mean with standard deviation [SD] or median (IQR) as appropriate were used to describe the features of the baseline data and the surgical outcomes in the present study. All statistical analyses were performed using SPSS 20 (Statistics Package for the Social Sciences for Windows).

Results

Patients' characteristics

Thirty-six TF grade II or higher patients with persisting symptoms longer than four months and unresponsive to conservative treatment were invited to participate in the study. Two patients were excluded because they met some of the exclusion criteria. Thirty-four eligible patients with 40 fingers received the US-guided percutaneous A1 pulley release with needle technique as indicated in the Methods section. One patient (one finger) was excluded from the study analysis due to post-operative lost follow-up. Therefore, 39 fingers from 33 patients were included for the present study analysis (Figure 4 shows the study flow diagram).

Most patients were female (75.76%), the mean age (± SD) was 63.97±8.11 years. Mean symptomatic duration (± SD) before study operation was 7.44±4.37 months. Most patients (93.94%) reported right-hand dominance. Twenty-one TF (53.85%) occurred on the dominant hand and 18 TF occurred on the non-dominant hand (46.15%). The most affected finger was middle (38.46%) followed by index (20.51%), ring (20.51%), thumb (17.95%) and little (2.56%) fingers. Table 1 presents the patients' baseline characteristics.

Surgical outcomes

Mean operative time (± SD) was 6.17±1.70 minutes. Most operated finger pain (92.31%) could be managed by self-administering oral analgesic doses. However, three fingers (7.69%) had pain symptoms (two fingers at A2 pulley and another finger at A1 pulley) that were not controlled by oral analgesic medication but were resolved by triamcinolone injection into the pain location using US-guiding.

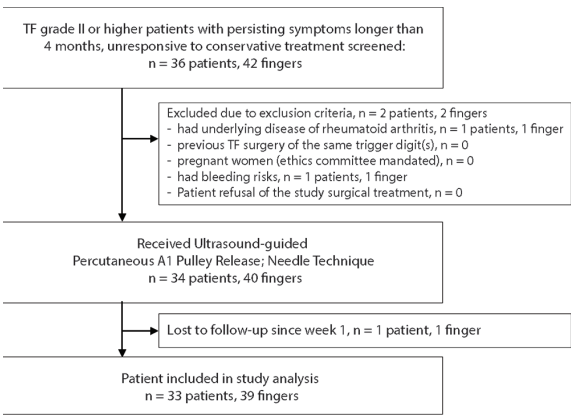

Figure 4. Study flow diagram.

Table 1. Patients' baseline characteristics (No. of patient = 33, No. of finger = 39)

Demographic characteristics	n = 33 patients, n (%)
Gender	
Male	8 (24.24)
Female	25 (75.76)
Age (year), mean ± SD	63.97±8.11
Hand dominance	
Right	31 (93.94)
Left	2 (6.06)
Trigger finger baseline characteristics, mean ± SD	
Symptomatic duration before study operation (month)	7.44±4.37

Affected digits	n = 39 fingers, n (%)		
	Left	Right	Total
Thumb	2 (13.33)	5 (20.83)	7 (17.95)
Index	1 (6.67)	7 (29.17)	8 (20.51)
Middle	6 (40.00)	9 (37.50)	15 (38.46)
Ring	6 (40.00)	2 (8.33)	8 (20.51)
Little	0 (0.00)	1 (4.17)	1 (2.56)
Total number of trigger fingers	15 (38.46)	24 (61.54)	39 (100)
Trigger finger in the dominant hand			21 (53.85)

SD = standard deviation

Median length of analgesic medication self-administration (paracetamol) was approximately 0.5 day, while median pain duration was around one day. Median time for return to normal activity after operation was two days, ranging from one day to one week. Average satisfaction score with wound appearance and overall treatment was 9.87 and 9.61, respectively.

Within 6-month follow-up period, only one patient (2.56%) revealed incomplete release of the A1 pulley (persistence triggering). The patient was re-operated with the same technique and had complete release of the A1 pulley after the second operation. At 6-month follow-up, six patients (15.38%) still had mild tension at the operated TF but did not obstruct to use the hand in daily activities. There were no severe complications, i.e., neurovascular injuries, hematoma, and surgical site infection, found throughout the study period.

Discussion

All consecutive TF adult patients with TF severity grade II or higher, who attended the outpatient clinic and met the inclusion criteria were invited to participate in the present study without any selection criteria. The ratio of women to men enrolled into the study was approximately 3:2. This conformed to general demographic of previous publications, i.e., the occurrence of TF is more in women[1-3].

Table 2. US-guided annular pulley release using needle outcome

Surgical outcome	n = 39
Operative time (minutes), mean ± SD	6.17±1.70
TF resolution after A1 pulley release, n (%)	
Revealed incomplete release within 6-month follow-up period	1 (2.56)
• Incomplete release found within 1 week post-operation	0 (0.0)
• Incomplete release found after 1 week post-operation	1 (2.56)
Pain, n (%)	
Pain required steroid injection within 1 week post-operation	3 (7.69)
Pain required only self-administering oral analgesic doses within 1 week post operation	36 (92.31)
Mild tender at operated finger at 6 months but not causing interfere of normal hand function	6 (15.38)
Time of use of analgesic doses (days), median (IQR)	0.5 (0.5, 2)
Pain duration after operation (days), median (IQR)	1 (0, 2)
Return to normal activity after operation (days), median (IQR)	2 (1, 2)
Satisfaction score with wound appearance (full score of 10), mean ± SD	9.87±0.40
Overall satisfaction scores (full score of 10), mean ± SD	9.61±0.74

US = ultrasound; SD = standard deviation; TF = trigger finger

The majority of TF in the author's study was the middle finger, followed by the index/ring, thumb, and little fingers, whereas most common finger in previous studies was the ring finger, followed by the thumb, middle, index, and little fingers[3]. The difference might be because of low sample size of the present study. Chaiwiriya conducted a study to compared efficacy in surgical treatment of TF between standard incision and mini-incision using A-knife, a percutaneous technique, and reported that mean operative time of percutaneous release using A-knife was significantly shorter than standard incision (10.16 versus 12.92 minutes). In the present study, the mean operative time was 6.17 minutes, which is less than the percutaneous release using A-knife reported by Chaiwiriya[20]. The differences of the present study and Chaiwiriya study were the cutting device (18-guaze needle used for the author's study and A-knife for Chaiwiriya study) and the use of US to guide the cutting device (used in the present study and not used in Chaiwiriya study). The shorter operative time might be result from US guiding that help the operator to clearly see distal and proximal end of A1 pulley, including flexor tendon during the operation. However, a study to compare between using A-knife and needles with US guiding might be required to confirm whether there was any difference in the cutting device.

Use of 18-guaze needle as cutting device gave smaller size of surgical wound compared to using A-knife that gave wound size of 3.08 mm long in approximate[20]. Use of US guiding that allows clear visualization of A1 pulley and guide the cutting device may result in decreased tendon and/or surrounding tissue injuries. These might lead shorter time to return to normal activity (around two days following the operation), shorter pain duration, and shorter duration of using analgesics (around half day). There were no neurovascular injuries found during the study period. Therefore, the author did not have to concern about neurovascular injuries using the technique (except for thumbs) because the area of procedure of the technique is located in the middle of the flexor tendon volarly.

However, A1 pulley release for trigger thumb is more difficult in comparison to other fingers and requires experienced operator because thumb flexor tendon does not place in longitudinal plane and limitation of extension of interphalangeal and metacarpal joints of thumb. In addition, there are differences of anatomy between the thumb and the long fingers. Flexor tendons of the long fingers run through the carpal tunnel and pulleys, which parallel to neurovascular bundles of their ulnar and radial side at A1 pulley. However, the thumb is different, the radial proper digital nerve of the thumb from median nerve at carpal tunnel run from ulnar side to radial side of flexor tendon of the thumb crossing just about before proximal edge of A1 pulley[21]. These characteristics of thumb make it difficult to position US probe and limitation of area for the cutting device. Moreover, the proximity of the neurovascular bundle and the A1 pulley in the thumb may cause more neurovascular injuries from the operation than the other fingers.

There are two main percutaneous pulley release methods for the treatment of TFs, i.e., the first method is US guided intrasheath percutaneous release using hook knife, and the second method is US guided

extrasheath percutaneous release using needle as cutting device. For the first method, US is used to guide the blade to be advanced distally, just below A1 pulley for cutting[17,18]. For the second method used in the present study, US is used to guide the cutting device volarly over the A1 pulley (in an extrasheath position) with its blade directed volarly for its release. The first method (intrasheath technique) has lower possibility of incomplete release but the method is more complex when compared to the second method (extrasheath technique). The extrasheath technique has higher chances of incomplete release and flexor tendon injuries[17]. However, with the current US technology, both hardware and software, allow clearer visualization of A1 pulley than the US used in the past. In the future, US technology will be certainly more robust and reliable.

Persistent mild tension at six months after the A1 pulley release in six patients (15.38%) were observed but did not interfere with normal hand function. The incidence in the present study was consistent with the incidence reported by Gilberts and Wereldsma that 17% of patients still had mild residual pain and 16% still had stiffness of the treated finger after percutaneous surgery[22]. However, there was a difference of follow-up period (6 months in the present study versus 2.5 years in theirs). The cause of persistent mild tension might be from tendon scoring.

Single dose of 1 to 2 mg triamcinolone acetonide was injected in cut A1 pulley in the present study. The volume of steroid used was 1 to 2 ml. In terms of drug actions, steroids have antagonistic effects on growth factors and collagen deposition in wound healing[23] that might be the cause of wound healing delay and surgical site infection. However, there was no surgical site infection or wound problem in the present study, and all patients could use their hand as normal within two days. Furthermore, all patients were satisfied with the wound appearance and overall treatment. The present study showed that single dose postoperative intralesional steroid injection was safe. A retrospective study of postoperative intralesional steroid injections on wound healing reported that there was no difference wound healing duration and surgical site infection rate between the patients who received single dose postoperative intralesional steroid injections and the non-steroid group[24]. The aim of giving triamcinolone acetonide in the present study was to decrease inflammation at the operation site. This might also reduce pain after surgery.

There are some limitations of the present study, mainly from lack of control group to compare result with US-guided percutaneous A1 pulley release, needle technique without steroid injection postoperatively. Excellent result of the present study may be because of steroid rather than the release procedure itself.

Conclusion

US-guided A1 pulley release using needle as cutting device is an efficient operative technique for TF treatment that enables immediately recovery from TF, fast hand functional recovery with tiny wound size, very short pain duration, and low complication rates. Besides, the patients were also satisfied with wound appearance and overall treatment. Furthermore, this technique used a short operative time and can be performed in an outpatient setting without surgeon assistant, which enable the hospital to reduce the staff and instrument/facility costs. This technique could be performed safely if the operator had enough experience in the procedure.

What is already known on this topic?

US-guided percutaneous A1 pulley release needle technique is an option for treatment of TF.

What this study adds?

This study supports the efficacy and safety of the technique, including patient satisfaction.

Potential conflicts of interest

The author declares no conflict of interest.

References

1. Bonnici AV, Spencer JD. A survey of 'trigger finger' in adults. J Hand Surg Br 1988;13:202-3.
2. Giugale JM, Fowler JR. Trigger finger: Adult and pediatric treatment strategies. Orthop Clin North Am 2015;46:561-9.
3. Makkouk AH, Oetgen ME, Swigart CR, Dodds SD. Trigger finger: etiology, evaluation, and treatment. Curr Rev Musculoskelet Med 2008;1:92-6.
4. Carlson CS, Jr., Curtis RM. Steroid injection for flexor tenosynovitis. J Hand Surg Am 1984;9: 286-7.
5. Rayan GM. Distal stenosing tenosynovitis. J Hand Surg Am 1990;15:973-5.
6. Akhtar S, Bradley MJ, Quinton DN, Burke FD. Management and referral for trigger finger/thumb. BMJ 2005;331:30-3.
7. Cebesoy O, Kose KC, Baltaci ET, Isik M. Percutaneous release of the trigger thumb: is it

safe, cheap and effective? Int Orthop 2007;31: 345-9.
8. Dahabra IA, Sawaqed IS. Percutaneous trigger finger release with 18-gauge needle. Saudi Med J 2007;28:1065-7.
9. Habbu R, Putnam MD, Adams JE. Percutaneous release of the A1 pulley: a cadaver study. J Hand Surg Am 2012;37:2273-7.
10. Mishra SR, Gaur AK, Choudhary MM, Ramesh J. 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;17:112-5.
11. Sahu R, Gupta P. Experience of percutaneous trigger finger release under local anesthesia in the Medical College of Mullana, Ambala, Haryana. Ann Med Health Sci Res 2014;4:806-9.
12. Schramm JM, Nguyen M, Wongworawat MD. The safety of percutaneous trigger finger release. Hand (NY) 2008;3:44-6.
13. Zhao JG, Kan SL, Zhao L, Wang ZL, Long L, Wang J, et al. Percutaneous first annular pulley release for trigger digits: a systematic review and meta-analysis of current evidence. J Hand Surg Am 2014;39:2192-202.
14. Daftary AR, Karnik AS. Perspectives in ultrasound-guided musculoskeletal interventions. Indian J Radiol Imaging 2015;25:246-60.
15. Paulius KL, Maguina P. Ultrasound-assisted percutaneous trigger finger release: is it safe? Hand (NY) 2009;4:35-7.
16. Smith J, Rizzo M, Lai JK. Sonographically guided percutaneous first annular pulley release: cadaveric safety study of needle and knife techniques. J Ultrasound Med 2010;29:1531-42.
17. Rojo-Manaute JM, Soto VL, De las Heras Sanchez-Heredero, Del Valle SM, Cerro-Gutierez M, Martin JV. Percutaneous intrasheath ultrasonographically guided first annular pulley release: anatomic study of a new technique. J Ultrasound Med 2010;29:1517-29.
18. Rojo-Manaute JM, Rodríguez-Maruri G, Capa-Grasa A, Chana-Rodríguez F, Soto Mdel V, Martín JV. Sonographically guided intrasheath percutaneous release of the first annular pulley for trigger digits, part 1: clinical efficacy and safety. J Ultrasound Med 2012;31:417-24.
19. Rajeswaran G, Lee JC, Eckersley R, Katsarma E, Healy JC. Ultrasound-guided percutaneous release of the annular pulley in trigger digit. Eur Radiol 2009;19:2232-7.
20. Chaiwiriya P. Efficacy in surgical treatment of trigger finger by mini-incision using A-knife: a randomized controlled experimental Study. Reg 11 Med J 2015;29:417-23. [in Thai]
21. Schöffl V, Heid A, Küpper T. Tendon injuries of the hand. World J Orthop 2012;3:62-9.
22. Gilberts EC, Wereldsma JC. Long-term results of percutaneous and open surgery for trigger fingers and thumbs. Int Surg 2002;87:48-52.
23. Wicke C, Halliday B, Allen D, Roche NS, Scheuenstuhl H, Spencer MM, et al. Effects of steroids and retinoids on wound healing. Arch Surg 2000;135:1265-70.
24. Grumbine N, Dobrowolski C, Bernstein A. Retrospective evaluation of postoperative intra-lesional steroid injections on wound healing. J Foot Ankle Surg 1998;37:135-44.