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Research Article

Tourniquet-free pediatric trigger thumb release: Single-center experience and clinical outcomes

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ABSTRACT

Objective: This study aimed to evaluate the efficacy and safety of pediatric trigger thumb release performed without tourniquet application.

Methods: This retrospective study included 17 trigger thumb releases in 16 patients (11 female, 5 male) performed between October 2021 and December 2023. The mean patient age at surgery was 2.81 ± 0.75 years (range, 2-4). All procedures were conducted at a single center under deep sedation or laryngeal mask airway anesthesia using a transverse volar incision at the metacarpophalangeal joint to release the A1 pulley. Outcomes included postoperative range of motion, complications, reoperation, and parent-reported satisfaction. The mean follow-up was 38.87 ± 13.95 weeks.

Results: Full interphalangeal joint range of motion was achieved in 94.12% of cases, with no major complications and no reoperations. Minor postoperative events occurred in 17.65 (3/17) of cases, including a superficial wound infection managed with oral antibiotics and early residual flexion deformity that resolved with physiotherapy within 2 months. Overall satisfaction was high, with most families reporting they were "very satisfied" with the surgical outcome.

Conclusion: Tourniquet-free pediatric trigger thumb release appears to be a safe and effective option, achieving high rates of motion recovery and satisfaction without major complications.

Level of Evidence: Level IV, Therapeutic study.

Introduction

Pediatric trigger thumb represents approximately 2% of all upper extremity abnormalities encountered in children.[1] Its prevalence ranges from 0.5% to 3% per 1000 children, with a higher incidence observed in Asian and Hispanic populations.[1,2]

Unlike trigger fingers in adults, histological examinations of the A1 pulley and Notta's node sections in the pediatric age group have revealed significant amounts of mature collagen and fibroblasts without degenerative or inflammatory changes.[3] The condition primarily arises from anatomical incongruity between the flexor pollicis longus (FPL) tendon and the A1 pulley, leading to tendon swelling or thickening of the A1 pulley.[4]

The treatment options for pediatric trigger thumbs (PTT) range from non-interventional observation to conservative management with stretching and splinting to, ultimately, open surgical intervention.[5] The literature does not reach a definitive consensus on the treatment choice, initial approach, or most appropriate timing for treatment.[6]

Most authors consider open A1 pulley release under deep sedation with a tourniquet to be the optimal treatment for PTT.[7,8] To date, no published reports have described performing this procedure without tourniquet application. Considering the relatively low vascularity of the central volar aspect of the thumb and the superficial location of the A1 pulley, adequate visualization and hemostasis may potentially be achieved without tourniquet application in selected pediatric trigger thumb cases. This study aimed to evaluate the outcomes of pediatric trigger thumb surgeries conducted without a tourniquet by documenting cases performed in a single clinic where this approach has been used routinely over an extended period.

Materials and methods

Following approval from the Ankara University Ethics Committee (Approval number: İ04-350-24; Date: May 21, 2024), a retrospective review was conducted of 17 pediatric trigger thumb cases in 16 patients who presented to the clinic and underwent surgery between October 2021 and December 2023. Written informed consent for the use of anonymized clinical data and intraoperative images for scientific research purposes

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was obtained from all patients (parents) as part of the standard surgical consent process; all data/images were anonymized and contained no identifiable information.

All patients were initially managed conservatively with passive stretching exercises under the guidance of the physical therapy department. Patients younger than 1 year of age were routinely observed because of the higher likelihood of spontaneous resolution. Surgical treatment was generally considered after at least 6 months of conservative management in patients with persistent triggering, flexion deformity, or lack of clinical improvement. In the institution, surgery is usually recommended after 2 years of age, whereas patients between 1 and 2 years of age are managed individually according to their clinical course.

All procedures were performed under deep sedation or laryngeal mask airway anesthesia, without local anesthetic infiltration. A single prophylactic antibiotic dose was administered 30 minutes before the skin incision. All surgeries were carried out at a single center in a hand surgery clinic by either a faculty member or a resident, using a transverse incision over the volar aspect of the metacarpophalangeal (MP) joint to release the A1 pulley.

The following variables were recorded: sex, age, operated side, age at presentation, associated congenital anomalies, family history, presenting symptoms and clinical findings, surgical outcomes, treatment effectiveness, patient satisfaction, and postoperative complications. Because of the minimal expected blood loss in this procedure, quantitative blood loss measurements were not performed. Instead, intraoperative bleeding was indirectly assessed according to the number of surgical gauzes used and the requirement for postoperative dressing replacement.

Surgical technique

Following successful intravenous anesthesia induction, an approximately 1.0 cm skin incision was made along a transverse line over the Notta's nodule on the palmar aspect of the MP joint. Subsequent dissection proceeded vertically to avoid damage to the bilateral blood vessels and nerves. Intraoperative visualization was maintained through meticulous soft tissue dissection, gentle retraction with small Langenbeck retractors, and careful protection of the neurovascular bundles. Electrocautery was not routinely required because intraoperative bleeding was minimal in most cases.

Traction was applied to both sides using small Langenbeck retractors to expose the tendon sheath of the FPL muscle, and the fibrous layer of the swollen tendon sheath (A1 pulley) was longitudinally incised along its axis. After the release of the A1 pulley, the range of motion (ROM) of the thumb's interphalangeal joint was assessed; if passive ROM was normal, the incision was closed with absorbable sutures provided that the tendon moved smoothly and did not catch.

HIGHLIGHTS

- Tourniquet-free A1 pulley release for pediatric trigger thumb achieved high rates of full interphalangeal motion recovery.
- No major complications or reoperations were observed during a mean follow-up of ~39 weeks.
- Minor postoperative events were infrequent and resolved with simple measures (oral antibiotics or physiotherapy).
- Parents reported high satisfaction after tourniquet-free surgery.
- Avoiding a tourniquet may reduce tourniquet-related risks while maintaining favorable clinical outcomes.

Additionally, the potential contribution of a variable pulley (Av) further proximally, which could cause additional narrowing in the FPL tendon, was examined (Figure 1).

Long-arm bulky dressing was applied to immobilize the thumb in maximal feasible extension. Long-arm bulky dressing was preferred in order to reduce the risk of accidental dressing removal in very young children, protect the surgical site, and maintain thumb extension during the immediate postoperative period. Patients were discharged on the evening of the same day once vital signs were stable. Postoperative medication was limited to an oral analgesic syrup.

Postoperative follow-up

Postoperative evaluations were performed during routine outpatient follow-up visits by the operating surgeon or supervising faculty member. Patients were routinely evaluated at postoperative week 1, month 1, and subsequent follow-up visits depending on clinical recovery. Wound healing, thumb motion, residual triggering, pain, deformity, and possible complications were assessed at each visit. Passive and active interphalangeal joint range of motion was assessed clinically and compared with the contralateral thumb. Residual deformity was defined as persistent flexion posture or extension limitation during examination. Parent-reported satisfaction was recorded during final follow-up visits using a simple qualitative assessment ("very satisfied," "satisfied," or "unsatisfied") based on overall cosmetic and functional outcome.

Statistical analysis

Statistical analyses were performed using StataMP 13 statistical software (StataCorp LP, College Station, TX, USA). Continuous variables are presented as mean ± standard deviation with minimum–maximum values, and categorical variables as number (percentage). Because of the retrospective design and limited sample size, the study was primarily designed as a descriptive observational series.

Results

The study included 16 patients and 17 cases; only 1 had a trigger thumb in both hands. The average age of the patients in the study is 2.81 ± 0.75 years (min 2–max 4). There were 11 female (68.75%) and 5 male (31.25%) patients. The average age of symptom beginning was 19.44 ± 5.43 (min 6–max 25) months. Only 3 patients (18.75%) were diagnosed before 12 months of age. None of the patients had a family history of congenital trigger finger or other congenital anomalies. No additional congenital hand anomalies were identified. Two patients had other congenital anomalies: One had surgically repaired cleft lip, and the other had clubfoot treated with serial casting during infancy. The summary of the findings is given in Table 1.

When examining the symptoms and findings of patients at the time of admission, the most common complaint was a loss of extension at the interphalangeal joint (11 patients, 68.75%), followed by the presence of the Notta nodule (3 patients, 18.75%). For only 1 patient, parents reported a painful range of motion in the thumb.

The mean operative time was 9.88 ± 0.81 minutes (min 9–max 11). No complications, such as vascular or nerve damage, developed during or after the operation. Patient satisfaction with the medical treatment process was rated as "very satisfied" in 14 cases and "satisfied" in 2 cases. The 2 patients who rated their satisfaction as "satisfied" expressed complaints about the palpability of the Notta nodule beneath the skin.

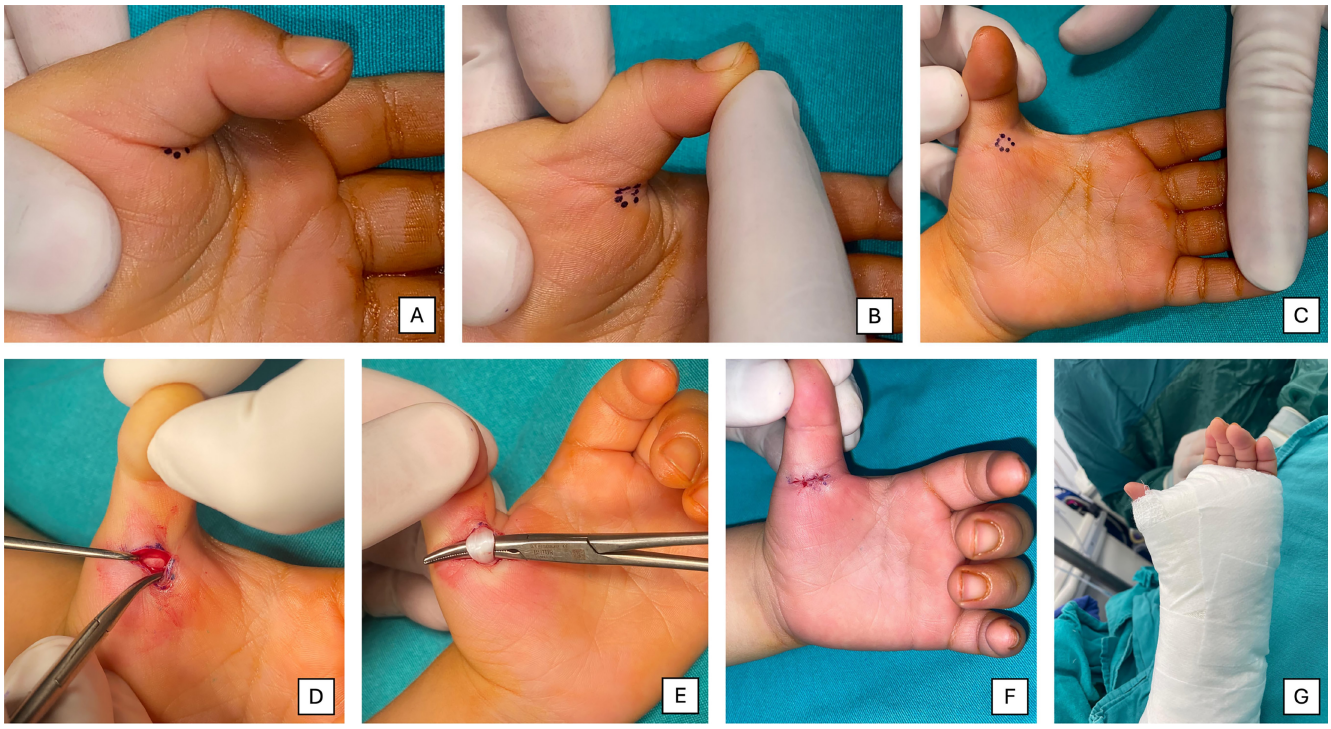


Figure 1. Surgical technique summary. (A and B) It depicts the flexion deformity at the interphalangeal joint. (C) It illustrates the marking of the Notta nodule. (D) It displays the transverse incision at the metacarpophalangeal joint level and the A1 pulley beneath. (E) It demonstrates the released FPL tendon and the Notta nodule. (F) It exhibits the wound closed with an absorbable suture. (G) It showcases the bulky dressing applied postoperatively. FPL, flexor pollicis longus.

Patients were followed up for an average of 38.87 ± 13.95 (min 19–max 75) weeks. At the end of the follow-ups, complete ROM was achieved in 16 thumbs (94.12%), with no reports of any catching or pain.

Three postoperative complications were observed. One patient developed a hematoma that required a dressing change and resolved spontaneously. Another patient developed a superficial wound infection that was treated with oral antibiotics. One patient had residual flexion deformity in the early postoperative period, which resolved completely with physiotherapy within 2 months. No major complications occurred, and no patient required reoperation. Mild preoperative bilateral MCP joint extension deformity was observed in one patient and remained unchanged postoperatively.

Discussion

This study assessed the feasibility and clinical outcomes of tourniquet-free pediatric trigger thumb surgery. In a clinic where open A1 pulley release is routinely performed without tourniquet application, a retrospective series of 17 operated thumbs (16 patients) was reviewed, demonstrating favorable postoperative outcomes, no major complications, no need for reoperation, and high parental satisfaction.

For surgeons, tourniquet use can be advantageous under certain operating conditions, particularly in delicate hand procedures in which maintaining a dry operative field may otherwise be challenging. A tourniquet facilitates a bloodless field, enhances visualization of the relevant anatomy, and may theoretically shorten operative time. However, tourniquet application may not be necessary in selected cases, especially when the surgical corridor is not highly vascular. The vascular anatomy of the thumb and fingers has been well described, and the midline volar incision commonly used for A1 pulley release is generally located in a relatively low-vascularity zone compared with adjacent tissues. Brunelli and Gilbert[9] noted that, despite the robust vascularity of the thumb overall, the principal arterial structures are concentrated along the radial and ulnar borders, leaving the central volar aspect comparatively less vascular. Sharma and Bhardwaj[10] similarly emphasized that the neurovascular bundles course along the sides of the thumb, supporting the safety of a central volar approach. Matloub et al[11] detailed the venous anatomy of the thumb, reporting that most venous drainage is dorsal, which may further reduce the likelihood of clinically significant bleeding during a central volar incision. Additionally, Ramírez and Gonzalez provided anatomical descriptions consistent with this distribution, further supporting the use of a central volar incision for trigger digit release.[12] With meticulous technique and careful protection of the neurovascular bundles, trigger thumb release can be performed without a tourniquet while maintaining adequate visualization and hemostasis and avoiding potential tourniquet-related concerns (venous stasis, endothelial damage, and platelet aggregation;[13] temporary compartment syndrome,[14] hyperthermia,[15] pulmonary gas exchange disturbances[16]). Figure 2 illustrates the vascular anatomy of the thumb and highlights the relatively avascular corridor corresponding to the typical incision site.

Successful treatment in PTT relies on patient and family compliance, and prior studies suggest that success rates decline as the deformity becomes more rigid on passive examination.[17] The optimal timing of surgery in pediatric trigger thumb remains controversial, as some patients may improve spontaneously during prolonged observation. In clinical practice, a 3- to 6-month trial of conservative management is typically implemented unless a fixed interphalangeal (IP) flexion contracture is present; surgical release is recommended when no improvement is observed. Accordingly, in the present series, a limited period of conservative treatment (maximum 6 months) was followed

Table 1. Summary of the study group's demographic, clinical, and surgical data

Age	2.81 ± 0.75 (2-4)
Sex	
Male	5 (31.25)
Female	11 (68.75)
Symptom beginning (months)	19.44 ± 5.43 (6-25)
Additional anomaly	2 (12.50)
Family history	0 (0.00)
Symptoms	
Limited extension	11 (68.75)
Nodule (Notta)	3 (18.75)
Triggering	1 (6.25)
Pain	1 (6.25)
Signs	
Flexion deformity and nodule	11 (68.75)
Flexion deformity	1 (6.25)
Nodule	2 (12.50)
Triggering	2 (12.50)
Sugimoto classification	
1	1 (6.25)
2	7 (43.75)
3	4 (25.00)
4	4 (25.00)
Watanabe classification	
1	6 (37.50)
2	6 (37.50)
3	4 (25.00)
Side	
Right	12 (75.00)
Left	3 (18.75)
Bilateral	1 (6.25)
Surgeon	
Faculty member	13 (81.25)
Resident	3 (18.75)
Follow-up (weeks)	38.87 ± 13.95 (19-75)
Surgery duration (minutes)	9.88 ± 0.81 (9-11)
Surgical dressing use	1.18 ± 0.54 (1-3)
Clinical outcomes	
Full range of motion	16 (94.12)
Residual deformity	1 (5.88)
Postoperative complication	
None	14 (82.35)
Wound infection	1 (5.88)
Neurovascular deficit	0 (0.00)
Pain	0 (0.00)
Hypertrophic scar	0 (0.00)
Flexion deformity	1 (5.88)
Hematoma	1 (5.88)
Revision surgery need	0 (0.00)

Continuous variables are presented as mean ± standard deviation (minimum–maximum), and categorical variables as number (percentage).

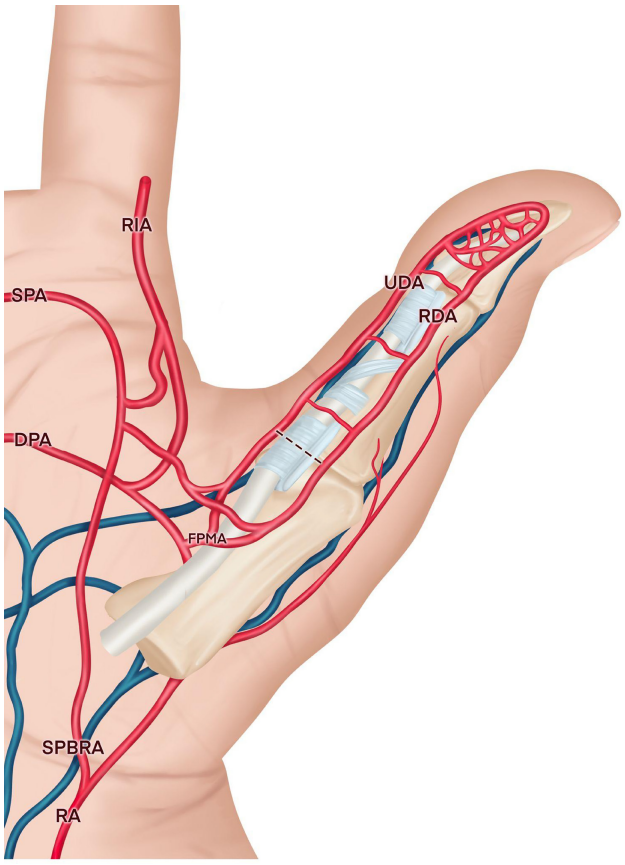


Figure 2. Illustration of the anatomical structures of the thumb, highlighting the positioning of arteries and veins. Arteries (along with nerves) are located on both sides of the pulley, distant from the center. The venous return of the thumb is predominantly at the dorsum. This arrangement ensures that the volar transverse incision at the A1 pulley level (marked by a dashed black line) is clear of both arteries and veins, suggesting no need for a tourniquet. DPA, deep palmar arch; FPMA, first palmar metacarpal artery; RA, radial artery; RDA, radial digital artery; RIA, radial indicis artery; SPA, superficial palmar arch; SPBRA, superficial palmar branch of the radial artery. (The illustration is created by Dr. Davut Oğulcan Çelik.)

by surgery before further progression of deformity in patients below Sugimoto stage 4 and Watanabe stage 3. No major intraoperative or postoperative complications occurred, and no patient required reoperation. Minor postoperative events were observed in 3 patients (17%); although this proportion may appear higher than in some tourniquet-based series, no major adverse outcomes were encountered.[18] Despite occasional dissatisfaction on follow-up and persistence of a palpable nodule consistent with tendon thickening even long after surgery, nodule excision is not recommended. Excision may weaken the tendon or, rarely, predispose to rupture. After A1 pulley release, triggering and friction typically diminish, and the nodule generally decreases in size over time.[19,20]

The sex distribution, affected side, mean age at initial presentation, and mean age at surgery were consistent with previously published data.[21] The mean operative time of 9.88 minutes in this series supports that the procedure is technically straightforward when performed by an experienced hand surgeon. However, this duration is approximately twice that reported for tourniquet-assisted release.[6]

Although tourniquet-free surgery may slightly prolong operative duration, adequate visualization was achieved in nearly all cases with meticulous surgical technique. While tourniquet-assisted release typically requires less time (5 minutes), no major complications related to prolonged surgery or impaired visualization occurred despite the relatively longer operative duration in the present series. Intraoperative bleeding was negligible in all but 1 case, in which the amount of gauze used was approximately 3 times the series mean.

In the literature, open release with a tourniquet for PTT has shown a success rate of 99% with a recurrence rate of only 1%, primarily attributed to inadequate surgical release.[22] Although tourniquet complications are uncommon in routine hand surgery practice, avoiding tourniquet use may still represent a practical alternative in selected cases when adequate visualization and hemostasis can be achieved. In addition to avoiding potential tourniquet-related complications, tourniquet-free surgery may provide practical advantages in pediatric patients. Avoiding tourniquet inflation eliminates the need for additional limb compression and may reduce soft-tissue pressure–related discomfort, postoperative swelling, and transient circulatory disturbances. The main limitations of this study are the small sample size and the lack of a tourniquet-based control group. The relatively small sample size limits statistical power and reduces the generalizability of the findings. The absence of a comparative control group precludes

direct comparison between tourniquet-free and tourniquet-assisted techniques. So, the study was primarily designed as a descriptive observational series. In addition, although patient-reported outcome measures and standardized pediatric hand outcome scores could offer valuable insight and strengthen methodological rigor, their routine application was considered difficult in this very young patient population. Furthermore, range of motion was assessed clinically rather than by standardized goniometric measurements. However, given the very young age of the study population, the primary outcome was complete correction of the deformity, which could be reliably assessed during routine clinical examination and confirmed by parental observation. Strengths include the use of both operative records and objective postoperative clinical examination findings, supplemented by parent-reported assessments of the postoperative course. The relatively long follow-up period further supports the reliability of the observed outcomes. In conclusion, this preliminary single-center experience suggests that pediatric trigger thumb release without tourniquet application may be a feasible and safe alternative in selected patients when performed with meticulous surgical technique. However, given the retrospective design, limited sample size, and lack of a comparative control group, further comparative prospective studies are required before definitive conclusions can be drawn.

Data availability statement: The data that support the findings of this study are available on request from the corresponding author.

Artificial intelligence usage statement: ChatGPT-5.6 (Sol; OpenAI) was used exclusively for language editing purposes in the preparation of this manuscript.

Ethics committee approval: Ethical committee approval was received from the Ethics Committee of University of Ankara (Approval no: İ11-1084-25, Date: 21.05.2024).

Informed consent: Written informed consent was obtained from the patients who agreed to take part in the study.

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