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Research Article

Treatment Outcome of Trigger Thumb in Children

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Abstract

Purpose: To report the surgical treatment outcome of pediatric locked trigger thumb by sequential release of the annular pulley and partial release of the oblique pulley.

Materials and Methods: A retrospective review was undertaken on 55 operative thumbs in 42 patients with an average follow-up of 55 months. Intraoperative observations focused on the pathology of the pulley system. Surgical technique involved complete release of the annular pulley A1, along with release of the proximal 50% of the oblique pulley in all patients. Postoperative parameters of bowstringing, resolution of Notta's node, thumb interphalangeal motion, and patient parent satisfaction were assessed.

Results: There ware 42 patient, 55 thumb were operated. Boy: 16; Girl: 13. Right: 15; Left: 14. Age onset: 4.0 ± 2.269 months, onset in bilateral group (61.5%) earlier more unilateral (29%) (Pvaluate: 0.0195); Age at Diagnosis: 11.75 ± 3.491 nonths, ; Classification of trigger thumb: Type 2: 6, Type 3: 23, group bilateral with Type 3 (69.2%) more unilateral group (10.3%) (Pvaluate: 0.02104) ; Age at Operation: 21.620 ± 7.970 (≤ 12 moths: 3. > 12 - ≤ 36 months: 49. > 36 months: 3) operative under 18 months in bilateral group (37.9%) more unilateral group (7.7%) (Pvaluate:0.0157); Follow-Up time 50.1 months, Good 90.9%, Fair: 9.1%. (bilateral beter unilateral group (Pvaluate: 0.0185). No patients had recurrence of thumb locking or triggering. No bowstringing was detected, and Notta's node resolved fully in 28 of 55 thumbs. All patients or families expressed overall satisfaction with the procedure.

Conclusion: Mistaking the constricted proximal oblique pulley for an annular pulley may encourage releasing the entire oblique pulley, leading to an adverse result. Satisfactory outcome was achieved after surgical treatment of pediatric locked trigger thumbs.

Keywords: Congenital Trigger Thumb; Locked Thumb; Oblique Pulley; Annular Pulley

Introduction

Paediatric trigger finger (PTT) is a rare disorder occurring up to ten times less frequently than its counterpart, paediatric trigger thumb. [1]. Though prevalence rates specific to PTT are scarce, triggering of any digit, thumb or finger, is reported to affect less than 0.05% of children [2].

The cause and treatment of trigger thumb in children have both remained controversial. A congenital theory was proposed in view of its presentation at birth and its occurrence in twins, siblings and first-degree relatives [3]. The acquired theory was first suggested by Sprecher [4] in 1949 who believed that the naturally clasped position of the thumb in the palm, combined with the strength of the grasp reflex would result in microtrauma and eventually lead to a flexion contracture of the thumb.

Several authors have found no incidence at birth and very few presenting within 6 months of birth [5] while others have found an association between trigger thumb and trauma [4]. These findings led Slakey and Hennrikus [5] in 1996 to suggest that this condition be termed 'acquired thumb flexion contracture' rather than congenital trigger thumb.

The treatment of trigger thumb has traditionally been surgical release as most authors found no cases of spontaneous recovery [5]. In contrast, some other authors have found recovery rates ranging from 10% to nearly 50% [1]. The Japanese have also reported success rates as high as 89% with splint therapy.

Saeed Banadaky and Baghianimoghadam [6] provide evidence of successful treatment with casting while Shiozawa., *et al.* [7] and Nemoto., *et al.* [8] report successfully treating PTF using splinting. Nevertheless, the majority of studies demonstrate satisfactory results using surgical methods to treat triggering digits [1].

Furthermore, PTT is much less common than adult trigger finger, a condition which exhibits a 2.6% prevalence rate in non-diabetic adults over the age of 30 [9]. Most published studies offer evidence and treatment modalities for paediatric trigger thumb, or they focus on paediatric trigger thumb with a few PTT cases added into the data collection [10].

The evidence base to guide treatment of PTT in isolation is limited. Although published management algorithms and strategies have reported good outcomes through a variety of different means, there is no general consensus as to the best method to treat PTT.

The purpose of this study is to present a systematic review of the literature and evaluating results for Peasdiatrc Trigger Thumb at Vietnam Hospital for Peadiatrics.

Materials and Methods

A retrospective study was carried out on patients with pediatric flexion deformity of the thumb IP joint treated surgically by the senior author. From 2000 to 2010, 55 thumbs in 42 consecutive patients were treated. There were 22 boys and 20 girls. The average follow-up period was 54 months (range, 39 - 74 months).

All members have confirmed consensus. The study was approved by the Ethics Review Committee of our Institute and was conducted in accordance with the tenets of the Declaration of Helsinki.

The inclusion criteria were children with congenital trigger or locked thumbs who underwent surgery and could be contacted for follow-up. At initial evaluation, nonoperative management was offered for patients presenting with symptoms of less than 6 months or those who had no prior therapy. This involved observation or therapy in the form of passive stretching exercises by the parents, supervised by a therapist. Surgical treatment was recommended at initial presentation if the patient had failed prior stretching therapy advised by their pediatrician or presented with symptoms of greater than 6 months or longer. Patients who had no resolution after a 3-month period of observation or stretching therapy were then advised to undergo surgery.

Patient demographics

The mean age was 22 months (range, 4 - 9 months) at onset, 11 months (range, 4 -18 months) at presentation, and 21 months (range, 10 - 38 months) at surgery. There wasn't case of trigger thumb noted at birth. In Eleven patients (26.2%), the condition was noted in the first year of life, 25 (59.5%) between 13 and 36 months, and six (14.3%) beyond 36 months. In many cases, however, the parents were not certain about the exact time of onset. Four patients were siblings but not twins. Five patient's families reported traumatic events to the affected hand; one involved a fall onto the affected side and the other could not recall the exact nature of the trauma. There were no associated congenital musculoskeletal or systemic anomalies.

Subjective evaluation

Preoperative symptoms and their duration were obtained from the records and the family, noting whether the affected thumb triggered or locked in a position of flexion or extension. At follow-up, hand function and parent or patient satisfaction with treatment outcome were assessed. Patients were rated as either satisfied or dissatisfied, with no gradations. Assessment of hand function was based on ease of hand use and any difficulty in hand use.

Objective Evaluation

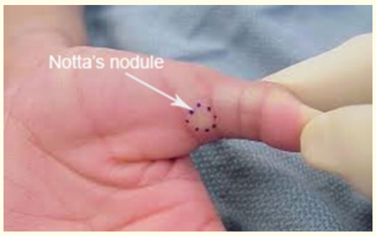


Figure 1: Notta's nodule.

Figure 2: A-B. Clinical Trigger Thumb.

Preoperative range of motion of the thumb IP joint and degree of flexion deformity were retrieved from chart review. Postoperative assessments included: recurrence of flexion deformity, thumb IP range of motion, status of Notta's node (Figure 1), and presence of FPL tendon bowstringing. Flexion deformity and range of motion-were determined using a goniometer. Bowstringing was observed as superficial displacement of the tendon and overlying skin. Persistence of Notta's node was determined clinically as a prominence and palpable nodularity at the MP flexion crease as compared to the unaffected side (Figure 2).

Classification of trigger thumb [11]

Classify the level of trigger thumb pathology into 3 types

- **Type 1:** Finger I flexes < 20º Flexion and extension movements of finger I still have the ability to stretch to 0º.
- **Type 2:** Finger I flexes ≥ 20 - ≤ 30º Flexion and extension of finger I sometimes extends to 0º.
- **Type 3:** Finger I flexes > 30º Flexion and extension movements of finger I are not able to stretch to 0º.

Operative procedure

Preoperative planning

For trigger thumb, it is crucial to examine both thumbs preoperatively to ensure that this condition has not developed on the contralateral side. If the child is older than 4 years or if the thumb has been stuck flexed for a prolonged period, a lateral radiograph can identify any articular changes at the IP joint that could affect the ability to achieve full extension immediately postop. These changes include beaking of the proximal phalangeal head and irregularity of the base of the distal phalanx, often remodel after release and nighttime splinting.

For trigger finger, a thorough history and physical exam are required to ensure there is no suggestion of underlying metabolic, rheumatologic, or other syndromes that may be associated with trigger thumb. Laboratory studies or further imaging may be required if the history is concerning, especially if multiple digits are involved.

Surgery according to the diagram in figure 3.

Operative techniques

The patient is positioned supine for both trigger thumb and trigger finger release with a hand table attachment. A lead hand can be helpful for trigger thumb release.

After successful intravenous induction of anesthesia, median nerve block anesthesia is performed under ultrasound guidance. An 0.5-1.0-cm incision is made along the transverse lines at Notta's nodule (Figure 4A) on the palm side of the metacarpophalangeal joint to incise the skin layer by layer and separate the subcutaneous tissue (may be slightly proximal to nodule in cases of thumb stuck in extension). Attention is paid not to injure the blood vessels and nerves.

Ensure that the incision is not too radial, which can place the radial digital nerve at risk by planning surgical incision on a line from the center of the child's thumbprint to the hook of the hamate. The skin incision should be carefully made just through the skin to prevent injury to the superficially located tendon and radial digital nerve. Blunt dissection is used to visualize the A1 pulley, and the radial and ulnar neurovascular bundles are retracted with small Ragnell retractors (Figure 4 B-C). The flaps and neurovascular tissue are retracted to opposite sides to expose the flexor pollicis longus muscle tendon sheath, and the fibrous layer of the hyperplastic tendon sheath is incised along the longitudinal axis of the tendon sheath. The synovial layer is not opened.

Next, the A1 pulley is incised with a #15 or beaver blade and then released fully proximally and distally using small scissors (Litter's) (Figure 4D). Check the release by simulating active FPL flexion by maximally extending the wrist and then squeezing the FPL muscle belly in the distal third of the forearm. Full extension of the thumb can be tested with tenodesis effect by maximally flexing the wrist. After pulley release, the ROM of the interphalangeal joint of the thumb is examined. If the ROM is normal, with smooth motion of the tendon, and the tendon is not entrapped, the incision is closed. The incision is dressed with plain chromic (5.0), and the thumb is immobilized in the dorsal extension position (open position of the thumb-index web space); Short forearm thumb spica cast (soft roll preferred for younger children) for 10-14 days. This protects the wound and also gives stretch to thumbs that have developed soft tissue contracture from being held in flexion. Regular and full activities are allowed once the cast is removed (Figures 6). Patients are periodically re-examined according to the function of the hand and thumb every 3, 6, 12 weeks and at the latest.

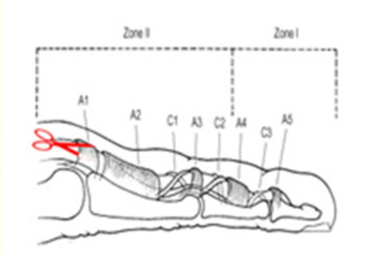


Figure 3: Cuting fibrous layer of the hyperplastic tendon sheath

- The skin must ge perform carefully because the radial digital nerve may coss the midline.
- Simple incision of the A-1 and partial resection have both been advocated.
- The nodule in the tendon is producted by constriction of the floxor tendon by the tight A-1 pukkey, and requires no further treatnent.

Figure 4: A. Incision about 1 cm; B-C. Expose Flexor pollixis longus and and the fibrous layer of the hyperplastic tendon sheath; D. Incised along the longitudinal axis of the tendon sheath

Figure 5: Postoperativly, Placed hand spica csat with thumb maximum abductor-Extension.

Figure 6: A. PostOperative clinical 3 weeks. B. Functional abductor Thumb.

	Thunb Full extended	Thumb function	Pain	Recurrence	Point *Quick* DASH
Good	(+)	(+)	(-)	(-)	> 50 points
Fair	(+)	(±)	(-)	(-)	> 30 - ≤50 points
Poor	(-)	(-)	(+)	(+)	≤ 30 points

Table 1: Evaluating result of operative Trigger Thumb.

Statistical analysis

Statistical analysis was performed using the SPSS statistical package program (SPSS version 19.0; SPSS Inc., Chicago, Illinois, USA). The t-test was performed to compare injured and uninjured elbows. The null hypothesis was that the mean extension and angle of inclination in the injured elbow after fixation would be the same as in the uninjured elbow (control). We used a P value of less than 0.05 to determine the statistical significance of the respective variables.

Result

Twenty-six of 55 thumbs (42 patients) had a flexion contracture of the IP joint preoperatively, with an average contracture of 59° (range, 20-80°). The Age average at surgery was 21 months) (Table 2,3).

Thirteen patients had bilateral involvement. Their age at onset was 5 months. In these patients, the side that resolved had a flexion deformity, whereas the contralateral thumb had a flexion contracture that required surgical release.

Subjective evaluation

Preoperatively, only four of 55 thumbs (7.3%) reported a history of triggering, whereas the remainder (94%) presented with locking of the thumb IP joint in flexion. At follow-up, none reported recurrence or residual flexion deformity of the operative thumb.

All patients or families expressed satisfaction with the procedure. Additionally, all patients or families reported normal function of both hands, with no compromise of hand use.

All reported resolution of Notta's node; however, two patient noted a small nodule of the nonoperative contralateral thumb that was asymptomatic. One patients reported decreased hyperextension of the thumb IP joint on the operative side.

These patients had pre-operative symptoms lasting 2 and 3 months, respectively, and were both diagnosed between 20-36 months of age. Five of seven patients or families reported being extremely satisfied (rating 5/7) with the procedure and overall results, while the caregiver of the three sibling patients gave a rating of five out of six despite optimal results in all other survey categories.

Objective evaluation

No recurrence was observed in any operative thumb and none demonstrated any triggering. Preoperatively, Notta's node (Figure 1) was detected in 28 of 55 thumbs (50.9%). Postoperatively, Notta's node had completely resolved in all but one operative thumb. This patient was diagnosed at 19 months of age and had minimal palpable prominence at the MP flexion crease without associated IP flexion deformity (Table 2,3).

Additionally, no FPL tendon bowstringing and hyperextension at the MP joint were detected at final examination. One thumb had 10° more active flexion compared to the nonoperative side, while eight thumbs (14,5%) had an average 15° less active IP joint flexion without associated contracture. These three thumbs underwent surgery after 36 months of age (5,5%). All thumbs had full active IP joint extension when compared to the nonoperative side.

Intraoperative results

Although on occasion, the anatomy could not be precisely ascertained, surgical observations overall revealed that the thumb pulley system to be similar to that described by Doyle and Blythe [13]. The first annular pulley was attenuated at the level of the MP joint in 20 of 36 thumbs, appearing nearly indistinct from the remaining proximal tendon sheath. Notta's node was visualized through and beneath this membranous annular pulley in all thumbs and consistently entrapped at the proximal border of the oblique pulley 28 of 55 thumbs (50.9%). Distally, the oblique pulley appeared stenotic in all 55 thumbs with prominent fibers thicker than the remaining tendon sheath and annular pulley. In these seven (12.7%) thumbs, the annular pulley was reported to be thickened. Initially, the attenuated annular pulley was fully released; however, performing this standard release in 21 of 55 (38.2%) thumbs did not achieve complete extension of the IP joint. Therefore, those thumbs required further release of at least the proximal 50% of the stenotic oblique pulley in order for full FPL excursion to be achieved.

	Gender	Age Onset (mo)	Side of involvement	Classifi-Cation Type	Age at DiagnosiS (mo)	Age at Operation (mo)	Follow-Up (mo)	Pain	Recurrence	Functional Limitations	Result
1	Boy	3	Right	2	4	10	42	N	N	N	Good
2	Girl	7	Left	2	13	14	39	N	N	N	Good
3	Boy	8	Left	3	10	11	66	N	N	N	Good
4	Boy	12	Right	3	15	20	68	N	N	N	Good
5	Girl	6	Left	2	10	18	45	N	N	N	Good
6	Boy	4	Right	2	9	22	48	N	N	N	Good
7	Girl	8	Left	2	15	26	55	N	N	N	Good
8	Boy	10	Left	3	19	38	62	N	N	N	Fair
9	Boy	2	Left	3	4	22	48	N	N	N	Good
10	Girl	4	Right	3	16	39	68	N	N	N	Good
11	Girl	9	Right	3	18	34	72	N	N	N	Good
12	Boy	6	Left	2	12	16	49	N	N	N	Good
13	Girl	5	Left	3	12	20	66	N	N	N	Good
14	Boy	6	Left	2	15	28	74	N	N	N	Good
15	Boy	9	Left	2	14	32	47	N	N	N	Fair
16	Girl	5	Right	2	12	14	45	N	N	N	Good
17	Girl	4	Right	3	10	18	62	N	N	N	Good
18	Boy	4	Left	2	13	15	56	N	N	N	Good
19	Boy	6	Right	3	9	20	48	N	N	N	Good

20	Girl	6	Right	3	8	12	38	N	N	N	Good
21	Boy	4	Left	3	10	14	48	N	N	N	Good
22	Girl	7	Right	2	11	19	56	N	N	N	Good
23	Girl	5	Right	2	10	24	70	N	N	N	Good
24	Boy	8	Right	3	12	32	44	N	N	N	Fair
25	Boy	9	Left	3	14	16	38	N	N	N	Good
26	Girl	7	Right	3	15	19	42	N	N	N	Good
27	Girl	8	Left	2	9	16	54	N	N	N	Good
28	Boy	6	Right	3	12	14	64	N	N	N	Good
29	Boy	5	Right	2	10	15	62	N	N	N	Good
	Mean	4.0	Right: 15		11.75	20.620	45.344				
	SD	2.269	Left: 14		3.491	7.970	11.120				

Table 2: Patient's data with unilateral thumb.

Boy: 16; Girl: 13. Right: 15; Left: 14. Age onset: 4.0 ± 2.269 months; Age at Diagnosis: 11.75 ± 3.491 Months; Classification of trigger thumb: Type 2: 6, Type 3: 23; Age at Operation: 20.620 ± 7.970 (≤ 12 moths: 3. > 12 - ≤ 36 months: 24. > 36 months: 3);Follow- Up: 45. 344 ± 11.120 months (39-74 months). Last results: Good: 26 (89.7%).Fair: 3 (10.3%).

	Gender	Age Onset (mo)	Classifcation type	Age at Diagnosis(mo)	Age at Operation(mo)	Follow Up (mo)	Pain	Recurrence	Functional Limitations	Result
1	Girl	6	3 3	10	18	45	N	N	N	Good Good
2	Boy	5	2 3	10	24	58	N	N	N	Good Good
3	Girl	8	3 3	15	26	55	N	N	N	Good Good
4	Boy	11	2 2	16	34	60	N	N	N	Good Fair
5	Girl	5	3 3	12	20	66	N	N	N	Good Good
6	Boy	6	2 3	14	22	54	N	N	N	Good Good
7	Girl	4	3 3	10	18	62	N	N	N	Good Good
8	Boy	4	2 2	13	15	56	N	N	N	Good Good
9	Boy	6	2 3	7	24	46	N	N	N	Good Good
10	Girl	8	2 2	11	19	56	N	N	N	Good Good
11	Girl	5	3 3	12	22	66	N	N	N	Good Good
12	Boy	9	3 3	14	30	42	N	N	N	Fair Good
13	Girl	8	3 3	9	16	52	N	N	N	Good Good
Mean		6.538		11.769	22.153	55.230				
SD		2.106		2.568	5.490	7.562				

Table 3: Patient's data with bilateral thumb.

Boy: 6; Girl: 7. Age onset: 6.538 ± 2.106 months; Age at Diagnosis: 11.769 ± 2.586 Months; Classification of trigger thumb: Type 2: 8, Type 3: 18. Age at Operation: 22.152 ± 5.490 (≤ 12 moths: 0. > 12 - ≤ 36 months: 13. > 36 months: 0); Follow- Up: 55.230 ± 7.562 months (42 – 55 months). Last results: Good: 24 (92.3%). Fair: 2 (7.7%). Classification Type 2: 9 (34.6%), Type 3: 17 (65.4%).

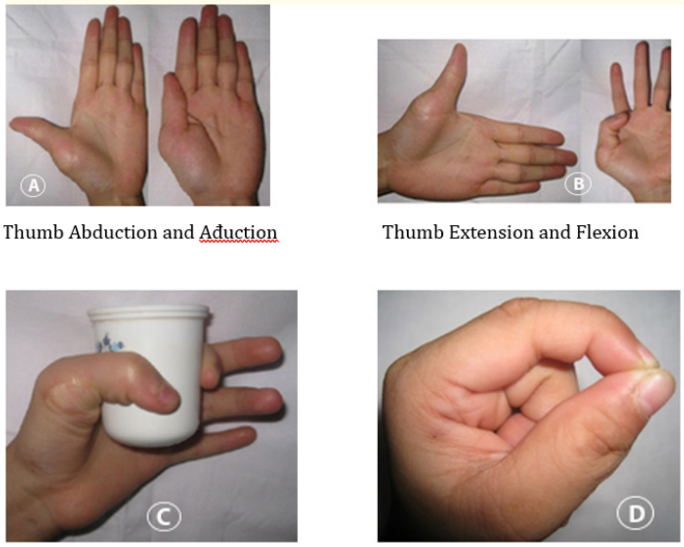
	Unilateral (29 Patients) 29 PTT	Bilateral (13 Patients) 26 PTT		Total
		Right	Left	
Good	26 (89.7%)	12 (92.3%)	12 (92.3%)	50 (90.9%)
Fair	3 (10.3%)	1 (7.7%)	1 (7.7%)	5 (9.1%)
Poor	0	0	0	

Table 4: Post Operative Result.

This Study have 55 PTT was operated, Latest result Good: 49 (89.1%) and Fair: 6 (10.9%).

Function of the thums

Pre-operatively, interphalangeal joint flexion, key pinch and tip pinch strengths were significantly diminished by the condition compared to the contralateral thumb (Table 5). Section of the A1 pulley effectively corrected these deficits of the thumb and there was no statistical difference between postoperative values and values for the contralateral side (Table 5). Although both key pinch and tip pinch strengths increasedpostoperatively, only tip pinch strength did so significantly (Table 5).



Thumb Abduction and Aduction

Thumb Extension and Flexion

Grip pinch

Two-pint pinch

Figure 7: A-C: Checking Postoperative functional thumb 52 months. The functional thumb was unlimited.

The width of the thumb increased significantly from pre-operative to final follow-up due to the bowstringing of the flexor pollicislongus. This increase was not enough, however, to show a difference with respect to the contralateral side (Table 5). This might suggest that the flexor pollicislongus was flattened against the first metacarpal by the thicker pulley before surgery.

	Affected Thumb		Contralat Thumb [12]
	Pre-Operation	Post-Operation	
IP Flexion (°)	50.2 (± 3.1)	63.6 (± 3.1)	66.6 (± 2.4)
MCP Flexion (°)	51.6 (± 1.8)	54.2 (± 1.8)	54.1 (±2.0)
Tip pinch strenth (kg)	3.8 (± 0.5)	9.8 (± 0.8)	9.7 (±1.0)
Key pinch strenth (kg)	5.6 (± 0.9)	6.7 (± 0.9)	7.6 (±0.8)
Witdth of the thumb (mm)	19.6 (± 0.4)	20.9 (± 0.4)	20.1 (±0.5)

Table 5: Function Pre-Post Operation and Contralateral data.

Complication

- Infection: 0
- Blood vessels and nerves injury : 0
- Hyperextension of finger I: 0
- Recurrent: 0

Discussion

The exact etiology of the pediatric trigger Thumb remains unknown. Several authors have described flexor tendon abnormalities accounting for triggering in their cases [13,14]. Whereas constriction at the A1 pulley is more commonly the cause of triggering in adults, it has been noted that nodular thickening or fusiform swelling of the flexor tendon is more frequently found in pediatric trigger fingers Calcifications or granulations within the tendon have also been described less commonly. Furthermore, anatomic aberrations of the FDS terminal slips and flexor tendon chiasm may also contribute to mechanical triggering. All of these findings were noted in the current investigation. Given the multiple etiologies of the pediatric trigger thumb, a diverse spectrum of surgical treatments have been proposed.

The term "trigger finger" is derived from the trigger of a gun and implies the snap sensed when the digit or thumb moves from a flexed to an extended position. This phenomenon is traditionally known to be due to a discrepancy in size between the enlarged flexor tendon and constricted annular pulley.

True triggering of the thumb in children is rarely reported, and the condition often presents as a locked IP joint in flexion [15]. As suggested by McCarroll, it is possible that triggering is unnoticed by the parents because of the natural clenched fist posture of the whole hand early during infancy or avoided by children because of associated discomfort.

The condition presented as a locked thumb in 93% of our operative thumbs, and only two thumbs had a history of triggering but none at presentation. Hence, the term "pediatric locked trigger thumb" is more appropriate than congenital trigger thumb.

Anatomical factors at the metacarpophalangeal joint may play a role. The normal flexed and adducted position of the newborn infant's thumb combined with the powerful grasp reflex may cause subtle trauma to the flexor tendon at the level of the A-1 pulley as it crosses the metacarpophalangeal joint [16]. The cartilaginous sesamoids behind the pulley may aggravate any stenosis.

Inflammation, synovitis, and tendon swelling result and the tendon sticks at the pulley and becomes locked in flexion [17].

Triggering is very rare; the digit is usually locked in persistent flexion. The term 'trigger thumb' is inappropriately borrowed from the adult condition in which snapping or triggering is common. There has been objection to the term 'trigger' because it implies snapping and we suggest that a more accurate description of this disorder is 'acquired thumb flexion contracture in children'.

The natural history of the condition is also controversial. Dinham and Meggitt [18] reported a spontaneous resolution rate of 30%, but others refute this claim [19]. Delaying treatment until after the age of three years may result in persistent [4] or permanent joint contracture [20,21]. In this study, all patients was checked functional thumb without limit (Figure 7).

Classifications

There are currently five author categories for Thumb and Finger Trigger. Basically, it depends on the degree flexion, the ability to move and control, the level of pain of the finger and thumb (Table 6 - 9). We have used Kazuki's Classification. 2006 [11].

Fingers into three different grades according to clinical severity at medical examination: grade I had a simple tenosynovitis with pain and tenderness, but without snapping; grade II demonstrated snapping in addition to grade I findings, but without loss of motion; grade III had loss of motion in addition to grade II findings. Grade I, II or III fingers with moderate or severe pain were classified as grade IP, IIP or IIIP, respectively. Jung., *et al.* [22].

The severity of the trigger thumb was graded from 0 to 3 according to the range of motion of the thumb IP joint and triggering. Grade 0 means that regardless of whether there is a mass in the region of the A1 pulley, the Joint can be actively extended to at least 0° without triggering. There are two subgroups in grade 0: 0A for extension beyond 0°; and 0B for extension only to 08. In grade 1, the IP joint can be extended actively but with triggering; in grade 2, passive but not active extension is possible but with triggering; Andin grade 3, the IP joint is fixed in a flexed or extended position and cannot be moved either actively or passively (i.e., itis locked) (Table 1).

Grade I	Simple tenosynovitis with pain and tenderness
Grade II	Snapping, but without loss of motion
Grade III	had loss of motion in addition to grade II findings

Table 6: Kazuki., *et al*. classification for Thumb and Fingers trigger.

Type	Condition
OA	Extension beyond 0° without inducing triggering
OB	Extension to 0°without inducing triggering
1	Active extension with triggering
2	Passive extension with triggering
3	Cannot be extension either actively or passively (i.e., linked)

Table 7: Type of trigger Thumb severity [22].

Green., *et al.* [23] Presenting symptoms graded according to the green classification.

Gards I	Pain or tenderness at the A1 pulley
Gards II	Catching but can actively extend digit
Gards III	Locking, requiring passive extension
Gards IV	Fixed flexion contracture

Table 8: The Green classification of Trigger Syrtoms [23].

4. Patel., *et al.* [24] Classifiction for digital stenosing tenosynovitis**.**

Stage	Finger and Thumb movements
1	Normal
2	Uneven
3	Triggering = Clicking = Catching
4	Locking of finger in flexion or extension unlocked by active finger movement
5	Licking of finger in flexion or extension unlocked by passive finger movement
6	Looked finger in flexion or extension

Table 9: Six stages of digital stenosing tenosynovitis.

Treatment

Age and Treatment.

Trigger thumb is a relatively uncommon condition. The cause remains unclear. Our review showed that out of 42 patients with trigger thumb, only 16 (30.1%) were detected under the age of 6 months, of which none was detected at birth. There were 13 cases of bilateral trigger thumb. This seems to suggest that the condition is acquired and not congenital. In this study, patient was operative under 18 months in bilateral group (37.9%) more unilateral group (7.7%) (P*valuate:*0.0157).

Dinham and Meggitt [18] noted spontaneous recovery of 30% for children who presented at birth, 12% for those who presented between 6 and 12 months and 0% for those who presented above 12 months. Mulpruek and Prichasuk [25] noted an overall spontaneous recovery rate of 24%. Dunsmuir and Sherlock [26] bserved an overall spontaneous recovery rate of 49% and noted that recovery rate appeared to increase with age. Our study showed an overall success rate of 66% in the group treated conservatively and this is higher than most reported series so far. The success rate appears to be higher in younger children and to decrease with age. Even for children above 3 years of age, however, the success rate was 50%.

This seems to suggest that of the patients who underwent immediate surgery, many may have had good outcome with conservative treatment, had it been implemented. The higher recovery rate in our series may be explained in part by the implementation of splint therapy, which appeared to have a high success rate, with Nemoto., *et al*. [27] reporting in their series an 89% success rate in patients treated with splint therapy.

Dinham and Meggitt [18] also noted an increased chance of a permanent contracture of the interphalangeal joint if surgical release was delayed until the children are more than 3 years of age. In our study, this was not noted and the age at surgery appears to have no influence on the outcome. This is in agreement with Skov., *et al.* [28] and Dunsmuir and Sherlock [26] who also found that delaying surgery until the children are above 3 years of age did not result in any residual contractures. We note that there is a much higher recovery rate following conservative treatment than previously thought and therefore recommend a more conservative approach to the treatment of this problem. While acknowledging the limitations of a retrospective study, our findings suggest that there is a difference in treatment outcome between splint therapy and passive stretching and we propose that prospective, randomized studies be done to draw more conclusive evidence.

Conservation

Trigger thumb is a relatively uncommon condition with a simple clinical diagnosis. However, aspects of its natural history, evolution, and especially indications for treatment are not fully known by surgeons, physiatrists, and pediatricians.[29].

Recently, much debate and discussion has focused on the effect of conservative treatment for pediatric trigger thumb.

According to several authors, the incidence of spontaneous recovery of trigger thumb in children ranges from 24% to 50%. Due to this reportedly low rate, many authors only considered surgical treatment in their studies. Albeit A1 pulley release has an excellent outcome, there is some disagreement about the best timing and age for the operation. Despite the fact that full motion is obtained in the immediate postoperative period it is an invasive procedure that requires general anesthesia in children, and has some complications, such as nerve injury (0.02%), superficial skin infection (0.03%), partial dehiscence of the suture (0.06%) and recurrence and residual contracture of the thumb after surgical release (4%). Recurrence is generally secondary to the inadequate release of the flexor tendon sheath. In conservative treatment, one of the major concerns is the duration that a patient can be kept under this treatment. In our study, we found no relationship with the longer use of splints and any complication.

Another major concern about conservative treatment is the prognostic factors that should encourage early surgical release. Previous reports have suggested that patients with bilateral trigger thumbs are not at a higher risk of residual triggering compared to children with unilateral trigger thumbs. Our results also showed no relationship between poor prognosis and bilateral trigger thumb. In this study, bilateral result better unilateral (P*valuate*: 0.0185).

Some authors [30] noted that the cure rate for patients with severe trigger thumb (locked) at presentation is significantly lower than that for patients with a less severe disease. In our cohort, we could not relate the severity of triggering at presentation with worse outcomes. In this study, In group bilateral with Type 3 (69.2%) more in unilateral group (10.3%) (P*valuate*: 0.02104).

Other authors [27] reported no connection between the patient onset age and outcome. In our cohort, the success rate appears to be higher in younger children and decreases with age. The importance of this study was that it had a large group that was assessed, guided and followed up uniformly by a single physiatrist, and it used the same protocol. A very suitable length of follow-up was achieved (average follow-up was 51 ± 8.5 months). In this study, onset in bilateral goup (61.5%) earlier more unilateral (29%) (P*valuate*: 0.0195)

Steroid Injection

In 1953, Howard [31] described the technique of steroid injection into the flexor sheath as an effective treatment It has since become an accepted initial treatment for the condition largely due to its ease of use within the outpatient setting, its low complication rate and the low rate of associated morbidity.

Steroid injections have an established role as the first line treatment for trigger digit, as they are safe, easy to administer and cost-effective.4) Surgical release of a trigger digit has a reported success rate of between 60% and 97%.

Unfortunately, surgery is associated with complications such as infection, nerve injury, tendon laceration, longstanding pain, contracture of the proximal interphalangeal joint and recurrence.[32]. A study by Thorpe in 1988 reported a total complication rate of 28% after surgery. It remains however the definitive treatment for patients who have no response to steroid injections or who have recurred following two or three steroid injections. Steroid injections have been found to be effective in the treatment of trigger digit. Its efficacy varies from between 67 and 90%. This study shows a slightly lower total efficacy of 66% with no reported complications.

The injection of steroids into the Xexor sheath has been advocated as a method of treatment of trigger fingers with success rates of 77-92% in thumbs and 67-84% in fingers. High success rates are seen when injecting the thumb and in patients in whom a well-defined nodule was palpable or whose symptoms had been present for less than 6 months.

Till today, we perform corticosteroid injections in all patients with trigger thumb or trigger thumb once or maximum twice and can follow the above-described excellent results of conservative therapy. Only in cases with failed corticosteroid injections, we recommend surgical release.

Splint

The treatment of trigger thumb has traditionally been surgical release as most authors found no cases of spontaneous recovery. In contrast, some other authors have found recovery rates ranging from 10% to nearly 50%. The Japanese have also reported success rates as high as 89% with splint therapy [27].

Treatment with a splint is impractical and unsuccessful in young children as is steroid injection. Operation is the only uniformly successful treatment. On top of the flexor sheath and closely applied to it are three pulleys, two annular and one oblique. The first annular pulley is located at the metacarpophalangeal joint and is the site of the constriction. The skin incision must be performed carefully because the radial digital nerve may cross the midline.

Simple incision of the A-1 pulley and partial resection have both been advocated. The nodule in the tendon is produced by constriction of the flexor tendon by the tight A-1 pulley and requires no further treatment.

Non-treatment of trigger finger causes flexion contracture in the interphalangeal joint. In this respect there is another significance. Some studies have reported spontaneous correction of the deformity, although those cases were below 12 months of age and were cases with mild symptoms. In the current study, the youngest case was 11 months old and because families were generally worried about surgical intervention, the children were brought to hospital at a mean 8.5 months after the onset of symptoms and during that time no improvement was reported.

Treatment choices include the use of splint/plaster, corticosteroid injections, physical therapy and percutaneous or open surgical loosening. The use of a splint may be useful in early stage cases and adults. Problems of conformity in pediatric patients may result in failure of the treatment.

However, in a study where long-arm plaster was applied to three patients aged 20, 26 and 32 months, it was reported that symptoms had recovered. Although there are studies defining the application of corticosteroid injections as the right approach, it is not as foolproof as indicated. The close proximity of digital blood vessels and surface course may cause partial tissue necrosis as a result of an injection within the digital artery.

Physical therapy methods include hot pack application, transcutaneous electrical nerve stimulation (TENS), ultrasound, friction massage and stretching exercises. Anti-inflammatory therapy may be given in addition to prevent inflammation. In two different studies where two cases aged four and five years old received physical therapy and anti-inflammatory therapy, positive results were reported from the treatment.

In another study, the mothers of children with trigger thumb were taught passive stretching exercises and after a mean 28 months of application positive results were obtained in the vast majority of cases.

Although there are different treatment methods in use, it has been suggested that particularly in childhood, surgery is required as the first treatment (Sevencan., *et al*., 2010 [33]. Surgical treatment is made in the form of a percutaneous or open incision in the longitudinal plane of the A1 pulley system. Amradi and Dardane [34] reported very good results from loosening operations performed on 63 cases aged between 12 and 60 months. Researchers have attempted the percutaneous approach, which has come into widespread use in recent years, because it consists of the loosening of the A1 pulley in the treatment of trigger finger. The percutaneous approach has been presented in literature as an alternative method with emphasis on surgery duration being longer than that of the open technique. The advantages are that the incision is smaller and thus there is less pain and it allows or early movement. The disadvantages are that the surgical area is small and the digital blood vessels, nerves and flexor tendons are in close proximity. For example, in cadaver studies small longitudinal tears were determined in the flexor tendons with the percutaneous method. In this respect, the risk of damage to blood vessels, nerves and tendons is greater than in the open technique. Particularly in pediatric cases, the close proximity of these structures and their surface course, increases the ris.

Percutaneous release

The common surgical treatments for trigger thumb include open release and percutaneous release. Compared with the open release, the percutaneous release is more rapid, less invasive, and less costly. However, the potential disadvantages of the percutaneous release are incomplete release and injury to either the tendon or nerve. Acupotomy, also called miniscalpel-needle or small needle knife, is now increasingly used for a variety of pain conditions, including trigger thumb. However, a few studies have indicated that acupotomy for trigger thumb also increased the risk of nerve or tendon injury.

Masquijo and colleagues [29] concluded that percutaneous release of the paediatric trigger thumb was not safe due to risk of iatrogenic injury to nerves and vessels as well as the possibility of an incomplete release of the A1 pulley. Due to differences in the underlying pathology of PTF and adult trigger finger, these methods of treatment may not be appropriate in the treatment of children. The results and analysis presented in this paper are subject to the limitations of the underlying studies including retrospective review, limited follow-up periods (three months in some instances), small sample sizes, non-randomized trials and possible non-adherence to splinting regimens. Furthermore, many of the articles relied on the researchers' judgement on whether a triggering digit resolved or failed, rather than measuring resolution versus failure with validated patient-reported outcomes. To our knowledge, no algorithmic method of treating PTF that includes the possibility of non-operative therapy currently exists in the literature. Additional randomized controlled studies are needed to truly qualify the benefits of one treatment method over another. Our review seeks to offer some guidance based on multiple centres' experience treating PTF successfully through a variety of different means. While our review supports the use of both surgical and non-surgical options, a step-wise treatment algorithm is useful to guide surgeons, particularly in lower volume centres. Based on our review of the literature we recommend a step-wise approach with re-evaluation after each measure to determine if triggering is still present.

This study found that both two techniques relieved triggering at short-term follow-up. It means that the modified acupotomy is as effective as percutaneous release. Most of the previous trials also found that no triggering occurred at short-term follow-up after percutaneous release. However, more recurrences (8.6%) were found in the percutaneous release group at long-term follow-up. Other studies observed similar recurrences (3.9-8.8%) in the percutaneous release group at long-term follow-up [35,36].

We divided thumb and fingers into six stages, each with increasing grades of mechanical problems (Table 9) and agree opinion of Patel., *et al.* [24] that: (1) Splinting. Splinting is most successful in trigger thumb. Patients are given a choice between splinting and injections. Patients who do not want to undergo splinting and patients who do not respond to splinting are treated with up to 3 cortisone injections at 2-week intervals. Patients who do not respond to injections are treated with surgery; (2) Injections. Thumb are treated with injec tions in all stages because the results of splinting are poorest in the thumbs. Patients who do not respond to injection are then treated with surgery; (3) Surgery. Do not splint or inject Thumb locked in flexion (stage 6); they are treated with surgery.

Surgery

The standard surgical approach for this condition has been well described in the literature and extrapolated from data on adult trigger thumbs. Many earlier studies vaguely described "incision of the pulley" or even "local excision of the sheath... as being a more reliable method than sheath incision". More recent literature has refined the surgical treatment to be incision of the A1pulley only with preservation of the oblique pulley to prevent bowstringing. Even so, this surgical approach is presumed based on the pathology being that of a constricted and thickened annular pulley.

In their series of pediatric trigger thumbs, van Loveren and van der Biezen questioned the role of the annular pulley in the pathophysiology. In 11 of 16 thumbs (69%), the stenosis was found distal to the A1 pulley, necessitating incision beyond that point. They concluded that the stenosis involved a separate annular pulley between the A1 and oblique pulleys. Although we did not detect a distinct pulley between the annular and oblique pulleys, we similarly found the stenosis to be distal to the first annular pulley. Our observations indicated the primary pathology involved the oblique pulley, which was stenotic, whereas the annular pulley was membranous and thin. Our findings are supported by our observation that Notta's node was consistently entrapped at the proximal border of the stenotic oblique pulley, rather than the annular pulley. This further correlates with the presentation of locking seen in 93% of our patients and is in agreement with Sprecher who stated that "when locking occurs, the nodule is always on theproximal side of the constricted area". Therefore, one must not mistaken a constricted oblique pulley as an annular pulley and proceed with releasing the entire oblique pulley. This may lead to bowstringing of the FPL tendon.

Bayat., *et al.* dissected [37] 14 adult cadaver thumbs and identified a distinct pulley, situated between the A1 and oblique, which they designated the variable pulley. They also performed a biomechanical study and noted that strain in the oblique pulley was greater during extension than flexion. Consequently, the oblique pulley alone failed to prevent bowstringing when both A1 and Av were released. These results may not be applicable to children's thumbs and anatomical studies of children's thumb pulley system have not been published, however, identified 1-2 mm of asymptomatic bowstringing in 25% of thumbs. These authors described performing either an "incision of the sheath" or resection of a "portion of sheath," thus the bowstringing may have resulted from a more extensive release [24]. We did not observe any bowstringing in our series, in spite of an extended release beyond the annular pulley involving about 50% of the oblique pulley. It is possible that the bowstringing encountered in prior series was due to mistaking the stenotic oblique pulley for an annular pulley and releasing the entire oblique pulley.

Day surgery

The following principles apply to diseases indicated for pediatric day surgery: The disease is common in children, the identical procedure is performed in a number of patients, and the operation can be implemented according to clinical pathway specifications; the surgical technique is mature and minimally invasive, with a short operative time; and the procedures are associated with mild postoperative pain, quick recovery, few complications, and no requirements for special care.

Han., *et al.* used A1 pulley release to treat trigger thumb in children and achieved good outcome of complete tendon release and well-recovered joint function, without postoperative pain or complications such as vascular or nerve damage [38]. Dinham., *et al.* reported the use of A1 pulley release to treat 105 patients with trigger thumb (131 thumbs). The range of motion (ROM) of the interphalangeal joints of the thumb was recovered completely in 100 thumbs. Reoperation was required in one thumb due to incomplete release. Incision infection was reported in one patient. Three patients had more than 15^0 flexion deformity of the interphalangeal joints for unknown reasons. The surgical remission rate was 95.2%. McAdams., *et al.* [39]. retrospectively analyzed the clinical data of 21 patients with trigger thumb (30 thumbs) with an average of 15 years of follow-up and reported no recurrence or interdigital dysfunction. They concluded that A1 pulley release is an effective treatment for pediatric trigger thumb [38]. In this study, 1,642 patients with thumb-stenosing tenosynovitis (1,930 thumbs) were included. The operative time was only a few minutes, and no complications such as vascular or nerve damage or severe pain after the operation were reported.

This study shows that as a procedure for the treatment of pediatric trigger thumb, A1 pulley release is appropriate for day surgery. The quality and safety of day surgery have become important factors in its development. Therefore, day surgery must implement a perioperative management system that is same as that used in traditional inpatient surgery. Ma., *et al.* [40] analyzed the clinical data of 129,869 pediatric patients undergoing day surgery under the centralized admission management model and found that strict adherence to the "three requirements" and "three evaluations" standards, a reasonable hospital observation time, standardized discharge education and follow-up, and a sound day surgery safety system can effectively reduce the rates of delayed discharge and postoperative complications. Therefore, the quality, safety, and overall management of day surgery are the same as or even higher than those of traditional surgery [41].

The results suggest that day surgery A1 pulley release for pediatric trigger thumb is a safe and reliable procedure. In this study, the wait time for scheduled surgery was between 1 and 13 days. Three children had postoperative fever and were discharged on the 2nd day after surgery. The other children were discharged on the day of surgery. The patient satisfaction survey showed a high degree of satisfaction with the medical treatment process, diagnostic and treatment workflow, treatment effectiveness, length of hospital stay, hospitalization cost, and discharge guidance.

Complications

Complications are very rare in trigger thumb release. To prevent radial digital nerve injury, take care in incision planning, perform under loupe magnification, and perform open, not percutaneous release. Although rare, recurrence can occur with incomplete release of oblique bands of the pulley so check motion intraoperatively to ensure complete release. Take care not to excessively release the thumb flexor pulley system, as this can result in flexor tendon bowstringing. If recurrence occurs, then treatment is often repeat release. Infection can be prevented by keeping surgical site clean and dry. Cast immobilization helps to keep the surgical site protected and stops the child from picking at the wound while healing.

Complications following surgical management of trigger finger are not very common but when occurring they may be severe [42]. The most important complications are digital nerve transection and inadvertent, tendon bowstringing.

Complications such as scar tenderness, infection, haematoma and stiVness may be more common after an open procedure, while complications such as digital nerve injury or tendon bowstringing may appear both after open and percutaneous procedures [41]. In respect to the serious complications in percutaneous release, we prefer the above-described open procedure. Open release has a success rate of 99%. In our study success rate was 100%. In this study, we did not encounter complications like in previous studies (Table 4).

Complication rate was 3%, but all complications healed uneventful. There were no serious complications such as nerve transection or bowstringing. In the cases of transient sensory deWcits neurolgic recovery was occured within the Worst 3 months after operation. Similar excellent results were published recently by Maneerit., *et al.* [42] for trigger thumbs. In our study, nerve injuries occured more often in the trigger thumb group.

Several authors have indicated that the proximity of the digital nerves in the thumb poses a considerable risk of injury when the percutaneous technique is used. In 2002, Gilberts and Wereldsma [42] published so-called long-term results after a mean follow-up of 2.5 years in percutaneous or an open surgery of trigger fingers. To our knowledge, we present the first the first long-term results of operative therapy of trigger Wnger of trigger thumb in adults. Taking our results into account, we prefer open surgery of trigger Wnger and trigger thumb using the above-described technique with excellent long-term results without recurrency.

Conclusion

Trigger thumb is a very common condition found in young children that can be easily treated with surgical release of the A1 pulley if it doesn't resolve with observation. It is important, however, to distinguish trigger thumb from trigger finger, which is much less common and can be associated with metabolic, rheumatologic, or other conditions. It can be treated with splinting, Injection, Day surgery or Operation but if surgical release is required, then the treating surgeon must recognize that multiple structures can contribute to operative results,

Limitations

Our study was retrospective, had a small number of patients, and had no control group. The surgical method is according to the classical technique, the outcome evaluation is also according to the standards already available. However, even though a large number of comparisons were not available, conclusions were drawn on the actual results obtained in the study.

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