Complete annular and partial oblique pulley release for pediatric locked trigger thumb

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Published online: 19 May 2010
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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 28 operative thumbs in 24 patients with an average follow-up of 79 months. Intraoperative observations focused on the pathology of the pulley system. Surgical technique involved complete release of the annular pulley, which alone was insufficient in relieving the deformity, 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 The oblique pulley appeared stenotic, whereas the annular pulley was observed to be membranous and nearly indistinguishable from the tendon sheath. No patients had recurrence of thumb locking or triggering. No bowstringing was detected, and Notta's node resolved fully in 19 of 20 thumbs. Five thumbs had an average of 12° less active IP joint motion without flexion contracture (i.e., less flexion). All patients or families expressed overall satisfaction with the procedure.

Conclusion The annular pulley was attenuated in the majority of cases and the proximal half of the oblique pulley was stenotic in all patients. Releasing 50% of the oblique pulley after complete annular pulley release was necessary in all thumbs to achieve full FPL excursion. 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.

Type of Study/Level of Evidence Therapeutic IV.

Keywords Congenital trigger thumb · Locked thumb · Oblique pulley · Annular pulley

Introduction

Congenital trigger thumb is a term used to describe a pediatric condition involving fusiform hypertrophy of the flexor pollicis longus (FPL) tendon. This enlargement produces a nodularity of the FPL tendon, palmar to the metacarpophalangeal (MP) joint, termed "Notta's node" and results in a flexion deformity at the thumb interphalangeal (IP) joint. Triggering, although rare, has been reported [1, 2].

Congenital trigger thumb is thought to be a sporadic condition. Family history of similar involvement has been reported but is uncommon [3–10]. Since its initial description by Jahss in 1936, controversy has existed regarding the etiology of this condition and whether it is truly congenital or acquired. Recent articles reported a 0% incidence of trigger thumbs in large newborn populations [11–14]. Other reports, however, have documented the presence of the condition at birth [1, 4, 5, 15]. Hence, the term "pediatric locked trigger thumb" seems to be more appropriate than congenital trigger thumb.

It has been postulated that in addition to the FPL tendon enlargement, the pathophysiology may involve thickening of the annular pulley, as in the case of acquired stenosing tenosynovitis in adults [3–5, 13, 16–19]. The primary pathology of this condition has been alternately identified as involving either the pulley system or FPL tendon itself

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and remains unclear, as is the fate of Notta's node after surgery [5, 17].

The prevailing surgical approach for this condition is based on the anatomic description of the thumb pulley system by Doyle and Blythe, which consists of one oblique and two annular pulleys [20]. Standard practice has been incision of the proximal annular pulley with preservation of the oblique pulley to prevent bowstringing [1–3, 8, 14, 15]. There have been occasional reports in the literature, however, that this treatment has not always resulted in a complete correction of the deformity. Dinham and Meggitt reported two cases of operative failure requiring a second operation; one felt to be from inadequate release and the other from wound infection [21]. Tan et al. observed an overall recurrence rate of 1.4%, felt to be from inadequate release [22]. Similarly, Dunsmuir and Sherlock described a total of eight recurrences in 200 operative thumbs (4%) that responded successfully to reoperation [15]. In the largest series of reported recurrences, Marriott described seven recurrences in 94 thumbs (7.4%) after dividing the sheath at the MP joint [23].

We suspect that complete annular pulley release, alone, is insufficient in achieving full FPL excursion and IP joint extension. The purpose of this study was to report the surgical outcome of pediatric locked trigger thumb treated by sequential release consisting of complete division of the annular pulley and partial release of the oblique pulley. We sought to describe the pathology of the pulley system observed intraoperatively and document the fate of Notta's node after surgical treatment.

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 1988 to 2008, 50 thumbs in 39 consecutive patients were treated. There were 25 boys and 14 girls. Thirty-three patients were Caucasian, four were Hispanic, and two were African-American. Fifteen patients could not be located; however, 24 patients with 28 operative thumbs could be contacted and were the subjects of this study. Of these, 18 patients were available for examination; six patients (six operative thumbs) could not return for follow-up because of geographic distance, therefore a detailed telephone questionnaire was conducted (Table 1). The average follow-up period was 79 months (range, 3–228 months).

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 2-month period of observation or stretching therapy were then advised to undergo surgery.

A total of eight patients (ten thumbs) elected initial nonoperative management. Two patients' families (three thumbs) chose observation while six patients (seven thumbs) elected a trial of passive stretching exercises and waited an average of 7 months (range, 0.5–18 months) without resolution before operative intervention was requested. Sixteen patients (18 thumbs) elected to proceed directly to surgery, one of whom had failed a 16-month period of stretching therapy.

Patient Demographics

The mean age was 24 months (range, birth–54 months) at onset, 41 months (range, 13–122 months) at presentation, and 45 months (range, 15–128 months) at surgery. There was only one case of trigger thumb noted at birth. In seven patients (29%), the condition was noted in the first year of life, 14 (58%) between 13 and 36 months, and three (12.5%) beyond 36 months. In many cases, however, the parents were not certain about the exact time of onset. Two patients were siblings but not twins. Two patients' 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

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, 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

Table 1 Results of telephone questionnaire.

Patient	Recurrent triggering or locking?	Pain or excessive thickening of scar?	Functional limitations?	Resolution of nodule?	Symmetric range of motion?	Symmetric thumb size?	Overall satisfaction (0=unsatisfied; 5=extremely satisfied)
1	N	N	N	Y	N: less hyperextension at IP joint	Y	5
2	N	N	N	Y	Y	Y	5
3	N	N	N	Y	N: less hyperextension at IP joint	Y	5
4	N	N	N	Y	Y	Y	5
5	N	N	N	Y	Y	Y	4
6	N	N	N	Y	Y	Y	4

of Notta's node was determined clinically as a prominence and palpable nodularity at the MP flexion crease as compared to the unaffected side.

Surgical Technique

The procedure is performed under general anesthesia with tourniquet control. A transverse incision is made at the

thumb MP joint flexion crease, which is often adjacent to Notta's node. The radial and ulnar digital nerves are identified and gently retracted. The annular pulley is identified and incised longitudinally. The thumb IP joint is then passively extended to assess adequacy of release. If full correction of the flexion deformity is not achieved, additional release of the oblique pulley is undertaken until IP joint extension is complete. (Fig. 1a-d)

Figure 1 **a** This child has congenital locked thumb deformity with IP joint flexion of about 35°. **b** Intraoperative appearance of the thumb with flexed IP joint before partial release of oblique pulley (**c-d**).

Intraoperative appearance of the thumb with extended IP joint after partial release of oblique pulley.

Results

Twenty-six of 28 thumbs (24 patients) had a flexion contracture of the IP joint preoperatively, with an average contracture of 49° (range, 10 – 90°). The average interval from presentation to surgery was 3.5 months (range, 0–16 months). One patient presented as a recurrence 3 days after surgical treatment at another institution. Seven patients had bilateral involvement; however, three had resolution of unilateral flexion deformity with nonoperative treatment. Their age at onset was 1, 6, and 27 months, respectively. In these patients, the side that resolved had a flexion deformity, whereas the contralateral thumb had a flexion contracture that required surgical release. At follow-up examination, patient "M" (Table 2) who had onset of symptoms at 27 months of age was noted to have recurrent locking of the nonoperative thumb, which had initially resolved. This was painless and is currently being managed nonoperatively.

Subjective Evaluation

Preoperatively, only two of 28 thumbs (7%) reported a history of triggering, whereas the remainder (93%) 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.

Of the six thumbs in six patients evaluated by telephone survey, none reported recurrence of triggering or locking. All reported resolution of Notta's node; however, one patient noted a small nodule of the nonoperative contralateral thumb that was asymptomatic. Two 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 24–36 months of age. Four of six patients or families reported being extremely satisfied (rating 5/5) with the procedure and overall results, while the caregiver of the two sibling patients gave a rating of four out of five 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 (Figs. 2 and 3) was detected in 20 of 28 thumbs.

Table 2 Patients examined at follow-up.

Patient	Thumb	Affected side	Age at onset (months)	Age at surgery (months)	Follow-up (months)
A	1	L	24	128	8
B	2	L	12	101	225
C	3	R	29	42	128
D	4	R	1	22	41
E	5	R	9	22	19
	6	L			0–75°
F	7	R	54	59	57
	8	L			0–75°
G	9	R	22	32	209
H	10	R	17	24	11
	11	L			R: (+15°)–70° L: (+15°)–60°
I	12	R	19	34	79
J	13	R	31	34	117
K	14	L	9	83	22
L	15	L	26	29	96
M	16	L	27	33	18
N	17	L	45	49	84
O	18	L	24	55	29
P	19	R	birth	15	3
	20	L			R: 0–90° L: 0–75°
					0–90°
Q	21	R	24	28	3
R	22	L	12	49	26
					R: (+15°)–60° L: (+15°)–60°

(+) indicates hyperextension

Figure 2 Notta's node is seen preoperatively.

Postoperatively, Notta's node had completely resolved in all but one operative thumb. This patient was diagnosed at 54 months of age and had minimal palpable prominence at the MP flexion crease without associated IP flexion deformity. 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 five thumbs had an average 12° less active IP joint flexion without associated contracture (Table 2). These five thumbs underwent surgery after 24 months of age. All thumbs had full active IP joint extension when compared to the nonoperative side (Fig. 4).

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 [20]. The first annular pulley was

Figure 3 Notta's node is seen intraoperatively.

attenuated at the level of the MP joint in 24 of 28 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. Distally, the oblique pulley appeared stenotic in all 28 thumbs with prominent fibers thicker than the remaining tendon sheath and annular pulley. In these four thumbs, the annular pulley was reported to be thickened. Initially, the attenuated annular pulley was fully released; however, performing this standard release in all 28 thumbs did not achieve complete extension of the IP joint. Therefore, all 28 thumbs required further release of at least the proximal 50% of the stenotic oblique pulley in order for full FPL excursion to be achieved.

The patient who had recurrent flexion deformity, after surgery at another institution, was found to have had only the annular pulley released, with an intact oblique pulley.

Discussion

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 [5, 14]. 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

Figure 4 Full correction of IP joint flexion deformity is seen in this child, 3 weeks after A1 and partial oblique pulley release of this thumb.

avoided by children because of associated discomfort [24]. 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.

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" [17] or even "local excision of the sheath... as being a more reliable method than sheath incision" [5]. More recent literature has refined the surgical treatment to be incision of the A₁ pulley only [3, 4, 14, 15] with preservation of the oblique pulley to prevent bowstringing [24, 25]. Even so, this surgical approach is presumed based on the pathology being that of a constricted and thickened annular pulley [17].

In their series of pediatric trigger thumbs, van Loveren and van der Biezen questioned the role of the annular pulley in the pathophysiology [19]. 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 the proximal side of the constricted area" [17]. 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 14 adult cadaver thumbs and identified a distinct pulley, situated between the A₁ and oblique, which they designated the variable pulley (A_v) [26]. 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 A_v 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. Skov et al., 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 [1]. 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.

An average of 12° less IP joint flexion was seen in five (18%) of our operative thumbs as compared to the contralateral side. All patients' thumb IP joints reached the same degree of hyperextension as the nonoperative thumb, and none had flexion deformity or compromise of hand function. All five of these patients had their surgeries after the age of 24 months or older. It is possible that the delay in diagnosis and treatment had contributed to this minimal difference in IP joint motion as compared to the contralateral side. No MP joint hyperextension was noted. Overall, there was no correlation between difference in motion and age at time of surgery. This is similar to the findings by McAdams et al., who found no correlation in timing of surgery and the 23% of patients with IP motion loss and 17.6% with MP hyperextension [16]. Dinham and Meggitt observed residual flexion contracture in three of six patients diagnosed and operated on after 4 years of age and therefore recommended operating before this age [21]. Although there was no postoperative flexion contracture in our series, we did observe that 50% of patients with unilateral pediatric locked trigger thumb diagnosed at 24 months or older had less IP joint flexion.

Satisfactory surgical treatment outcome was achieved in our patients without recurrences. The annular pulley was attenuated in most cases, and the proximal half of the oblique pulley was stenotic in all patients. Partial oblique pulley release after complete annular pulley release was necessary in all thumbs to achieve full IP joint extension. Despite our extended release, we did not observe IP joint flexion deformity nor was there FPL bowstringing. Notta's node, postoperatively, resolved in nearly all patients.

Conflict of Interest The authors declare that they have no conflict of interest.

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