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A PROSPECTIVE CLINICAL STUDY OF THE A1 PULLEY IN TRIGGER THUMBS

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A prospective study was performed in 19 patients with trigger thumbs to define the anatomy of the A1 pulley of the thumb in this condition and to evaluate biomechanical parameters of the thumb after complete division of the A1 pulley. Pre- and postoperatively, flexion of the interphalangeal and metacarpophalangeal joints, key pinch strength and tip pinch strength were measured and compared with these measurements on the contralateral thumb. We identified three types of A1 pulley. The clinical data showed that there is no deficit with respect to motion and strength of the thumb after completely sectioning any of the three types of A1 pulley.

Keywords: A1 pulley, trigger thumb, flexor pollicis longus, anatomy, stenosing tenosynovitis

Doyle and Blythe (1977) studied the flexor tendon sheath and pulley system of the thumb. They identified two annular pulleys and one oblique pulley. Doyle and Blythe recommended that the oblique pulley be preserved during surgical treatment of trigger thumbs to prevent bowstringing and ensure normal function of the flexor pollicis longus tendon. However, Bayat et al. (2002), in an anatomical study on fresh frozen cadavers, reported a distinct annular pulley, which they called the “variable annular pulley”, between the A1 and oblique pulleys. They also found that the intact oblique pulley alone did not prevent bowstringing of the flexor pollicis longus tendon and suggested that this problem could only be avoided when treating trigger thumbs if either the A1 pulley or the variable annular pulley remained intact.

This prospective clinical study reports the anatomy of the A1 pulley of the thumbs of 19 patients undergoing treatment of trigger thumb and evaluates the motion and the strength of the thumb after dividing the A1 pulley.

PATIENTS AND METHODS

We studied 19 patients with idiopathic trigger thumb in whom conservative treatment had failed and who underwent surgery between July 2004 and July 2005. No patient had bilateral involvement. Fourteen patients were women with a mean age of 64 (range 45–83) years and five were men with a mean age of 63.4 (range 57–79) years. Eight trigger thumbs involved the dominant side and 11 involved the non-dominant side. Nine had locking that was passively correctable and two had the thumb completely locked in flexion. Exclusion criteria included rheumatoid arthritis, diabetes and treatment with steroids within the 3 months prior to surgery.

Pre-operatively, active flexion of the interphalangeal and metacarpophalangeal joints was measured with a simple goniometer. Key pinch and tip pinch strengths were also measured with a Jamar dynamometer (Model 0030J4, Clifton, NJ, USA). Each patient performed each test three times with each hand and the mean was calculated. A caliper was placed between the palmar metacarpophalangeal crease and the dorsal aspect of the thumb before any flexion of the thumb was performed to measure the width of the thumb. Pre-operative bowstringing was then evaluated by measuring the width of the thumb during resisted flexion.

Pain was graded pre-operatively from 0 to 10 using a visual analogue scale (VAS) in which 0 represented no pain and 10 the worst pain the patient had ever experienced.

Operative technique

In all cases, a digital block was performed with 0.5 to 1.0 ml of 2% plain lidocaine. This allowed patients to actively flex and extend the thumb during surgery. A 2 cm longitudinal V-shaped skin incision with the apex on the ulnar side of the thumb was made at the metacarpophalangeal crease to completely expose the A1 pulley. By retracting the skin and subcutaneous tissues, it was possible to see the flexor tendon and sheath for about 2 cm proximal and distal to the A1 pulley.
Anatomical study

All surgery was performed under 3.5 × magnifications by the same surgeon (JB). The gross morphological features of the A1 pulley were observed and recorded photographically during surgery and studied further on magnified photographs.

The A1 pulley was sectioned in the longitudinal axis of the thumb. Intra-operative bowstringing was measured with a slide rule between the anterior aspect of the first metacarpal bone and the posterior aspect of the flexor pollicis longus tendon at the level of the distal edge of the A1 pulley, with the thumb actively flexing. This intra-operative measurement allowed us to obtain a direct measure of the bowstringing as opposed to the pre- and postoperative measurement, which were, inevitably, indirect. However, these latter measurements allowed comparison with the contralateral thumb.

Postoperatively, all patients were allowed to actively flex and extend the thumb immediately. Stitches were removed 2 weeks after surgery and clinical follow-up was performed every 2 weeks thereafter. Of the 19

Fig 1 (a) Photograph and (b) diagram of the annular A1 pulley.
patients, four did not attend follow-up and the remaining 15 were evaluated until they were able to perform daily activities without restrictions or pain.

Postoperative evaluation

Evaluation included the same measurements of active flexion of the interphalangeal and metacarpophalangeal joints, key pinch and tip pinch strengths and postoperative bowstringing as carried out in the pre-operative period. Every clinical parameter was compared with the contralateral side. Postoperative pain was also graded from 0 to 10 with the VAS.

Normal distribution of data was confirmed with the Shapiro–Wilks test. Repeated measures analysis of variance (ANOVA) was used to evaluate motion

Fig 2 (a) Photograph and (b) diagram of the A1 pulley comprised of proximal annular and distal oblique fibres.
(interphalangeal and metacarpophalangeal flexion), key pinch and tip pinch strengths, and the width of the thumb, comparing the affected and the normal thumb before and after treatment. The paired $t$-test was used to further evaluate the difference when the ANOVA test showed significant results. An alpha ($\alpha$) level was set at 0.025 to avoid inflation of any type 1 error when preoperative data were compared to postoperative and contralateral side data.

RESULTS

Anatomical study

Three arrangements of the A1 pulley of the thumb were identified. In 12 patients, the A1 pulley was observed to be a single transverse structure with annular fibres perpendicular to the flexor pollicis longus tendon (Fig 1). In five thumbs, the A1 pulley was found to have a well-
defined proximal part made up of annular fibres and a
distal part with oblique fibres arising from the distal
edge of the annular proximal part. In all five of these
thumbs, the oblique fibres ran from ulnar proximal to
radial distal (Fig 2). Two patients had an A1 pulley with
both annular fibres and oblique fibres but no clear
definition between them (Fig 3). In all cases, after
dividing the A1 pulley, we found a well-defined seg-
mental condensation of annular fibres on the tendinous
side of the pulley.

The mean intra-operative bowstringing of the flexor
pollicis longus tendon was 3.4 (range 2–5) mm.

Clinical evaluation

Complete resolution of the triggering was achieved
immediately after surgical release in all 19 thumbs.

Fifteen patients were followed up for a mean of 10
(range 4–16) weeks, by which time they were all free of
pain and had normal strength subjectively. Of the 15
patients evaluated postoperatively, all were able to fully
extend the interphalangeal joint of the involved thumb.
The four patients who did not attend for follow-up were
contacted by phone. None had any pain and all four
could carry out daily activities without problems.

Pre-operatively, interphalangeal joint flexion, key
pinch and tip pinch strengths were significantly dimin-
ished by the condition compared to the contralateral
side of the pulley. We found pulleys with combinations of oblique
and annular fibres resembling the configuration of the A1 pulley we described
precisely, Bayat et al. (2002) performed an anatomical study and identified a distinct annular pulley between the A1 and oblique pulleys, which they called the “variable annular pulley”.

Examining the superficial (anterior) aspect of the
tendon sheath, we found annular pulleys, as described
by Doyle and Blythe, in 12 cases. In the remaining seven
cases, we found pulleys with combinations of oblique
and annular fibres similar to those described by Bayat et al. (2002). We were not, however, able to recognise the “variable annular pulley”, which these authors
described as a separate structure from the A1 pulley.

We also found a difference between the superficial (anterior) aspect of the A1 pulley and its dorsal aspect, or “gliding surface”. The latter was, in all cases, a well-
defined condensation of annular fibres on the gliding
surface. This difference has been identified previously in histological studies (Lundborg and Myrhage, 1977; Sampson et al., 1991).

With respect to the biomechanics of the pulley system,
Doyle and Blythe (1977) concluded that the oblique
pulley should be preserved or reconstructed to maintain
normal function of the flexor pollicis longus tendon. Experimental studies (Esplin et al., 1996; Zissimos et al., 1994) have shown that, when both the A1 pulley and the
oblique pulley are cut, considerable bowstringing of the
flexor pollicis longus tendon occurs, but normal kinematics of the thumb continue if either the oblique pulley or the first annular pulley remains intact. However,
Bayat et al. (2002) claimed that the oblique pulley plays
no role in preventing bowstringing, which they sug-
gested can be avoided if either the A1 or the “variable
annular pulley” is left intact.

Our clinical results agree with the findings of those
authors who suggest that the oblique pulley avoids
bowstringing of the flexor pollicis longus tendon.
Complete section of the A1 pulley produced a mean
intra-operative bowstringing of 3.4 mm but without

<table>
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<th>Table I—Pre-operative, postoperative and contralateral data</th>
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<td><strong>Affected thumb</strong></td>
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<td><strong>Mean</strong> (SEM)</td>
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<td>Tip pinch strength (kg)</td>
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<td>Key pinch strength (kg)</td>
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<td>Width of the thumb (mm)</td>
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IP: interphalangeal; MCP: metacarpophalangeal.

1Distance between the metacarpophalangeal crease and the dorsal
aspect of the thumb.

* P<0.025: Pre-operative versus postoperative (paired t-test).

†5 P<0.025: Pre-operative versus contralateral side (paired t-test).

DISCUSSION

In 1977, Doyle and Blythe described the anatomy of the
pulleys of the thumb as consisting of two annular
pulleys and one oblique pulley. However, gross ano-
tomical variation in the configuration of the A1 pulley has
been reported previously in a number of studies
examining the superficial (anterior) aspect of the tendon
sheath (Doyle, 1988; Kleinert and Lubahn, 1984; Strauch and de Moura, 1985). In order to define the
anatomy of the pulley system of the thumb more
adverse clinical effects postoperatively, either in respect of interphalangeal and metacarpophalangeal flexion or in respect of key pinch and tip pinch strengths.

The major limitation of this study was the small number of patients examined. A second potential problem is that the description of the A1 pulley relies on observations made through a 2 cm surgical approach to challenge the evidence of cadaveric studies with full exposure of the whole tendon sheath. In respect of this possible limitation, Bayat et al. (2002) estimated the A1 pulley to measure no more than 6 mm in length, which is only of the order of a quarter of the length of the incisions used in our study.

References


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