Original article

The keyhole technique for arthroscopic tenodesis of the long head of the biceps tendon. In vivo prospective study with a radio-opaque marker

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ABSTRACT

Introduction: In some clinical situations such as when the Long Head of the Biceps (LHB) is unstable or with an “hourglass biceps”, treatment is required. Tenodesis is an alternative to tenotomy to prevent the Popeye sign. Although sutures, anchors or interference screws may be used, they all have complications and drawbacks. Moreover, the number of failures is underestimated because it only considers the visible deformities of the arm. MRI provides more accurate assessment, but is more expensive. We hypothesized that Froimson’s “keyhole technique” which has been described in open surgery could be performed arthroscopically with similar clinical outcomes to conventional techniques and without the complications or drawbacks. We also propose an objective and less expensive assessment of treatment failure.

Materials and methods: This 12-month prospective study was performed by a single surgeon. All patients requiring LHB tenodesis underwent arthroscopic “keyhole technique” surgery performed at the upper edge of the Pectoralis major in the bicipital groove. The LHB was externalised, pulled back on itself and the intra-articular portion was resected. A metal marker was placed in the tendon. The latter was introduced into the keyhole and hangs spontaneously. The follow-up evaluation was performed during the third month with a clinical examination and a plain X-ray. Distal migration of the metal marker was the sign of the failure of tenodesis.

Results: Between January 1st and December 31st, 2013, 123 patients were included. There were 87 men (70.7%) and 36 women (29.3%) and mean age was 52.2 (27–71). Eighty-eight patients underwent arthroscopic rotator cuff repair. Twenty-three patients (18.5%) had tenodesis failure shown by distal migration of the metal marker on plain X-rays. There were 21 men and 2 women. Only 13 had a visible Popeye sign and 1 was severe. None of the patients felt any discomfort, fatigue or painful cramping. There was no difference in flexion and supination strength from the healthy side. No complications were noted.

Discussion and conclusion: We confirm the hypothesis that this arthroscopic technique is feasible and reproducible with clinical outcomes similar to conventional techniques but without the complications. The metal marker implanted in the LHB confirms the exact number of failures, which is a significant element in this study.

Level of evidence: IV.

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1. Introduction

Even if the function of the long head of the biceps (LHB) is controversial [1], treatment is sometimes necessary in the presence of an unstable, nearly torn, hourglass biceps or a SLAP lesion [2].

Simple tenotomy has been proposed associated with rotator cuff tear repair or even in unreparable tears [3–5]. Tenotomy is a simple, rapid technique that does not require immobilization and provides excellent results without the complications associated with implants [6]. Nevertheless, there is a risk of an unattractive result because of a prominent bump of the biceps muscle (Popeye sign, PS), reduced supination strength [5], and persistent muscle contractions. Treatment of this complication is difficult because of distal contraction of the muscle.

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To prevent the PS, arthroscopic tenodesis techniques have been developed with anchors or interference screws [7–10]. This type of surgery is associated with potential complications from the implants used.

The “keyhole technique” of tenodesis, first described in open surgery by Froimson and Oh [11], has long been considered the reference technique before the development of arthroscopy and anchors. We have shown that this “keyhole technique” could be performed and reproduced arthroscopically [12,13].

In the analysis of results, only pain, cramps, supination strength and the appearance of the arm were studied. Nevertheless, none of these criteria are signs of a secondary tear which is often difficult to identify in overweight patients and this suggests that the real number of torn tenodeses has been underestimated. Ultrasound, CT scan or MRI are costly, and are still difficult to interpret to determine tendon healing. We present a 12-month prospective single surgeon study of arthroscopic tenodesis of the LHB by the “keyhole technique” associated with a radio-opaque marker. This tenodesis was proposed in case of a positive O’Brien test, a subscapularis tear, supraspinatus tear, an hourglass biceps, biceps with a partial tear in men less than 75 years old and women less than 60. The goals of the metal marker were clearly explained to the patient in the preoperative consultation.

Our goal was to objectively evaluate the development of a secondary tear following tenodesis by simple X-ray. The metal marker was the original element to this study.

2. Materials and methods

For 12 months between January 1 and December 31 2013, 123 patients underwent arthroscopic tenodesis of the LHB by the “keyhole technique” performed by a single surgeon (JK). This technique was first described by Froimson and Oh in 1975 for tenodesis of the LHB in open surgery [11]. We have described an endoscopic version of this technique [12,13].

Surgery could be performed with the patient in the deck chair position or the lateral decubitus. After a simple tenotomy of the LHB on the upper rim of the glenoid, which allows the LHB to retract into its groove, 3 anterior and lateral approaches were necessary. These 3 approaches formed a 90° angle. Great care was taken to avoid injuring the terminal branches of the axillary nerve in the deep layer of the deltid (risk of wasting of the anterior bundle of the deltoid). The LHB was then extracted, turned on itself to double its diameter and the injured intra-articular portion was excised. A metal marker was placed in the tendinous loop (suture 2/0) (Fig. 1). An eyelet drill pin could be used to drill a 7 mm tunnel by superomedial approach that was oblique below and approximately 45° behind which was used as a relay to penetrate the prepared LHB tendon. Only one cortex was perforated and the tunnel was only 3 cm deep. A 3-mm Kerisson clamp was used in the distal part of the tunnel to create the keyhole. The surgeon felt the characteristic “click” when the LHB spontaneously locked without an implant and the metal marker was in an intradiaphyseal position on the postoperative X-ray (Figs. 2 and 3).

Eighty-eight of the 123 patients underwent surgery for an associated rotator cuff tear: 88 supraspinatus tears, 7 subscapularis tears and 11 distal resections of the clavicle. During the same period, 355 patients were operated on for rotator cuff tears with a simple associated tenotomy (or 232 patients were excluded from the review). There were 87 men (70.7%) and 36 women (29.3%). The mean age at surgery was 52.2 years old (range 27–71). The patients gradually began resuming sports at the end of the third month.

Follow-up was performed at postoperative month 3, which is a sufficient delay to evaluate healing of the LHB [14]. A clinical examination (evaluation of the deformity, discomfort, muscle fatigue, subjective supination strength), and a control X-ray to identify the radio-opaque marker were performed. The intervention was

considered to be a failure when the metal marker was outside the humeral diaphysis on the 3-month postoperative X-ray.

3. Results

All patients were present at the follow-up consultation, and there were no loss to follow-up.

Twenty-three patients or 18.5% of the cases (21 men and 2 women) presented with a visible tear of the tenodesis on the 3-month postoperative standard X-ray as shown by distal migration of the metal marker, which objectively and clearly confirmed the technical failure (Fig. 4). The metal marker migrated distally 3 to 6 cm away from the initial area of tenodesis compared to the immediate postoperative X-ray of the distal keyhole. For cosmetic results, only one patient (man) complained of an unattractive outcome but there was no loss of strength during flexion or supination. The other 22 patients (20 men and the only 2 women with tenodesis tears) did not notice any “descent” of the muscle, even if it was visible on examination in only 13 of them (13 men).

Flexion and supination strength was measured manually and was not different from the healthy contralateral side. There were no complications, residual pain in the area of tenodesis, and no pain associated with excess tension of fixation. There were no revision surgeries.

There were no complications associated with the placement of the metal marker. There were no fractures.

4. Discussion

Walch et al. [4] proposed a systematic procedure for the long head of the biceps in association with rotator cuff tear repairs, or in non-reparable tears. A tenotomy has the advantage of being technically simple and allows rapid rehabilitation. Published reports show very good results of the disappearance of pain [4,6]. However, the disadvantage of a tenotomy is that it can sometimes cause PS. This is an unattractive lump of the lower third of the arm due to relaxation of the muscle in the bicipital groove. The estimated frequency of this event varies between 40 and 70%. A reduction in supination strength has been reported that can be a problem in manual workers [15]. Some PS are associated with severe muscle cramps that do not necessarily disappear during long term follow-up. Open revision surgery may therefore be considered to release, re-stretch and attach the LHB or to perform associated highly selective nerve block. Those are invasive procedures with unpredictable results.

To prevent the risk of SP, different tenodesis techniques have been described. There is no consensus on the best technique. Tenodesis can be performed with a simple suture on adjacent soft tissue [16]. It can be reinforced with an anchor in the bicipital groove [7] or at the tip with a 12.9% PS rate [17]. Tenodesis by interference screw was first performed in 2002 [8,9,18]. Fixation is extremely solid [19,20]. It requires specific ancillary material associated with an implant. Some complications have been reported: cystic reactions in case of absorbable screws and pain associated with excess tension in the tenodesis. According to the authors SP occurred in 0–32% of these cases [21–26].

Other alternatives include “tenotomy/tenodesis” such as the “T-Tenotomy” described by Bradbury et al. [27] requiring extensive resection of the associated anterosuperior bump or the “Anchor shape technique” by Narvani et al. [28]. There are no published results for these different techniques.

The analysis of failures of the different techniques is usually only clinical, subjective and with no additional objective examination: the presence or not of the PS. The tenodesis failure rate is probably underestimated because it is difficult to confirm and clinically evaluate the PS. Lee et al. [17] only identified 11 PS clinically while MRI identified 15 with an underestimation of 30%. This deformity is barely or not visible in overweight patients. In our series, only 13/23 failures (56%) had a clinically visible PS and only 1 (4%) had a severe cosmetic deformity. Our study used a metal marker to perform an in vivo analysis of the success of LHB tenodesis by keyhole technique, which could be evaluated on simple X-ray. This was a prospective and continuous series in 123 patients by a single surgeon for 12 months. Failure occurred in 18.5% (23 patients), which is not better than with other techniques. However, our evaluation was real and objective. Our failures were more frequent in men: 21/87 men (24.13%) and 2/36 women (5.5%), perhaps because of increased muscular tension in men. None of our 23 failures reported muscle cramps or a loss of supination strength. These results suggest that simple tenotomy can be indicated as a possible option in these cases. Frost et al. [1] have already shown that tenotomies and tenodeses have the same success and satisfaction rates. Finally, the “keyhole” approach completely exposes the long portion of the biceps as well as the bicipital groove above the PM (Pectoralis Major). Although fixation is less solid in vitro than with an interference screw [19,20], it is reliable enough to allow immediate early rehabilitation. There is no problem with an implant or a risk of excess muscle tension because this manoeuvre is performed with the elbow extended. This technique controls the 4 zones of the topographic classification of LHB injuries described by Hedtmann et al. [29] in particular the bicipital groove. Finally, fixation without an implant and especially extra-articular fixation prevents the risk of local synovitis.

This study has a few limitations: supination strength was not measured objectively but subjectively in relation to the contralateral size. We did not have a specific dynamometer to obtain this measurement. However, the purpose of this measurement is to analyse the results of the tenotomy by a radio-opaque marker, which was not the purpose of this study.

5. Conclusion

We have confirmed the hypothesis that an arthroscopic “key hole technique” is both possible and reproducible. The analysis of the results according to the usual criteria of pain, comparative


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supination strength, and the PS provides us with results comparable to other published techniques without the associated complications and drawbacks. It presents the advantage of treating injuries located in the bicipital groove, which cannot be managed with classic techniques of proximal fixation. The study with a radio-opaque marker has never been performed in vivo: the migration of the marker at the end of the study objectively shows the failure of the technique. There were 18.3% failures in our results.

Disclosure of interest

The authors declare that they have no conflicts of interest concerning this article.

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