Three intrasubstance failures of a LARS™ ligament used for ligament reconstruction

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ABSTRACT

We report three cases of intrasubstance failure of a LARS™ (Ligament Augmentation and Reconstruction System) artificial ligament used for acromioclavicular joint reconstruction. The LARS™ ligament failed within four months of the index procedure. All patients underwent a revision procedure following an unsuccessful trial of conservative management. A modified second loop technique was employed during the revision procedure for all cases using the LARS™ ligament. All three patients achieved full recovery to pre-injury level function.

KEYWORDS

LARS™ – Coracoclavicular ligament reconstruction – Acromioclavicular joint dislocation

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Several techniques have been described for treatment of high grade acromioclavicular joint (ACJ) dislocations.¹ These include primary repair of the ACJ, fixation of the clavicle to the coracoid process, anatomical coracoclavicular ligament reconstruction, distal clavicle excision with soft tissue reconstruction and arthroscopic suture fixation. Coracoclavicular slings and suture anchors are frequently used as they provide strength similar to that of coracoclavicular ligaments.² Coracoclavicular ligament reconstruction using the LARS™ (Ligament Augmentation and Reconstruction System) artificial ligament (Corin, Cirencester, UK) has been shown to have good patient reported outcome measures in both acute and chronic ACJ dislocations of grade ≤III.^{3–5}

Normally, the LARS™ ligament is passed through the undersurface of the coracoid process and the ligament ends are fixed in the bone tunnels created in the clavicle with titanium interference screws (Fig 1). This was the preferred technique of the senior author (HCP). Different modifications of this technique have been described such as passing the excess ligament again around the coracoid in a figure-of-eight configuration (Fig 2) or passing it through the drill hole in the acromion, then under the coracoid again and back to the medial ligament (Fig 3).⁶ The latter recreates both the acromioclavicular and coracoclavicular ligaments. These modifications are generally used in revision cases. We present three cases of intrasubstance failure of LARS™ ligaments used for ACJ reconstruction that required revision surgery.

Case 1

A fit 26-year-old man presented with a year's history of pain around his clavicle radiating to the neck and periscapular region in his non-dominant arm following a rugby injury. He was found to have a grade III ACJ dislocation (Fig 4). He continued to be symptomatic following a period of conservative management with physiotherapy. He therefore underwent surgical reconstruction of his coracoclavicular ligaments using a LARS™ artificial ligament with a single loop technique (Fig 1). His postoperative radiography showed anatomical reduction of the ACJ (Fig 5). He recovered well with physiotherapy achieving a full range of pain free shoulder movement.

Four months later, the patient re-presented with a deformed distal clavicle with pain, following another fall on to his shoulder while slipping on some ice. Radiography revealed a recurrent dislocation of the ACJ (Fig 6). He initially elected to try conservative management but after 16 months without symptom relief, he wanted to consider a surgical solution.

For this reason, following informed consent, he underwent revision coracoclavicular ligament reconstruction with a LARS™ ligament using a double loop technique (Fig 2). The postoperative radiography confirmed good reduction of the ACJ (Fig 7). At the time of surgery, the LARS™ ligament was found to have failed with an intrasubstance tear at the middle portion of the ligament where it passed under the coracoid process (Fig 8). The clavicle–ligament interface was intact. The patient was followed up for a year, achieving good symptom relief and his pre-injury level of function.

Figure 1 Single loop technique used in LARS™ reconstruction of the acromioclavicular joint

Figure 3 Modified double loop technique through the acromion used in LARS™ reconstruction of the acromioclavicular joint

Figure 2 Double loop technique used in LARS™ reconstruction of the acromioclavicular joint

Figure 4 Preoperative x-ray of Case 1 showing grade III acromioclavicular joint dislocation

Figure 5 Postoperative x-ray of Case 1 showing reduction of the acromioclavicular joint

Figure 6 Pre-revision x-ray of Case 1 showing failure of fixation of the acromioclavicular joint

Figure 7 Post-revision x-ray of Case 1 showing reduction of the acromioclavicular joint

Case 2

A fit 43-year-old male manual labourer sustained a left-sided (non-dominant) grade IV ACJ dislocation while practising judo. This was an isolated injury and he was subsequently seen in our specialist upper limb fracture clinic. Informed consent was obtained after discussing the available options and the decision was taken to proceed with acute surgical reconstruction of the coracoclavicular ligaments using a LARS™ artificial ligament.

Three months following the index surgery, the patient re-presented complaining of discomfort and dissatisfaction at the cosmetic appearance of the shoulder. No new injury was reported. Baseline inflammatory markers were normal and no infective cause was found.

Owing to ongoing pain following ten months of conservative management, the decision was taken to revise the reconstruction. Revision was successful with good postoperative function and full range of movements.

Case 3

A 71-year-old male retired builder fell directly on to his right shoulder and sustained a grade III dislocation. As he

Figure 8 Intraoperative photograph showing failed LARS™ ligament held in forceps

continued to be symptomatic on conservative management at eight months, he underwent coracoclavicular ligament reconstruction using a LARS™ artificial ligament. Postoperative radiography demonstrated satisfactory reduction of the ACJ. His pain improved significantly after the surgery.

Two months later, the patient re-presented with recurrence of symptoms. Check radiography provided evidence of failed reconstruction with the LARS™ ligament. Owing to unsuccessful conservative management and ongoing pain, he underwent revision surgery five months after the index procedure. At the six-month follow-up visit, he had good improvement in pain and range of movements of his shoulder. Radiography at the last follow-up appointment showed maintenance of reduction of the ACJ.

A summary of these cases is given in Table 1. The senior author (HCP) undertook the primary and revision procedures on all three patients using a LARS™ LAC 30 CK ligament, which can withstand forces up to 1,500N. The surgery was performed in the beach chair position with a sabre incision. For cases 1 and 2, the primary procedure was carried out as per the operative technique described by the manufacturer, using a single loop around the coracoid process, with bone tunnels in the clavicle with appropriate screws (Fig 1). For case 3, a modified double loop technique (Fig 2) was employed as two failures had been encountered by then. The surgery was uneventful.

At the time of revision, it was noted that although there had been some fibrous ingrowth macroscopically in the synthetic ligament, the ligament had failed with an intrasubstance tear with no overt sign of infection (Fig 8). In all three cases, the tear was found to be in the middle part of the ligament with equal medial and lateral limbs. This was consistent with the part that was passing under the coracoid process. The clavicle–ligament interface was intact in all cases. The remaining ligament and screws were removed, and the decision was taken to revise the fixation with a new ligament using the old holes after they had

Table 1 Summary of the three cases

Case	Age at index procedure / sex	Mechanism of injury	Rockwood grade	Index procedure	Time from surgery to confirmed failure	Time from failure to revision surgery	Revision surgery	Final follow-up
1	26 M	Rugby	III	Single loop LARS™	4 months	16 months	Double loop LARS™	1 year
2	43 M	Judo	IV	Single loop LARS™	3 months	10 months	Double loop LARS™	1 year
3	71 M	Direct fall	III	Double loop LARS™	2 months	5 months	Modified double loop through acromion	6 months

been curetted and cleaned. Soft tissue samples and a portion of the surgically excised ligament remnant were sent for extended microbiological analysis but no organisms were grown. The histopathology report confirmed fibrous ingrowth in the LARS™ ligament.

The revision surgery was performed with a modified double loop technique in the first two cases to augment the repair. As this technique failed in the third case, the second loop was further modified by passing the LARS™ ligament through the drill hole in the acromion and around the coracoid process (Fig 3).

Discussion

The LARS™ artificial ligament has over 20 years of clinical use. During this time, LARS™ reconstructions have been clinically proved to be reliable procedures in many parts of the body.^{4,7-9} Developed in France in the 1980s by a French orthopaedic surgeon, Professor Jacques-Philippe Labourau, the first implant took place in 1992 in Dijon.¹⁰

The LARS™ ligament is made from industrial grade longitudinal polyester fibres, specifically polyethylene terephthalate chosen for its good biocompatibility and biomechanical characters to allow for rapid fibroblastic ingrowth.¹¹ The strength of the LARS™ artificial ligament is superior to that of the native coracoclavicular ligaments.¹² Biomechanical work on cadaveric coracoclavicular ligaments has shown that the intact ligament tends to fail in the midsubstance at around 500N of uniaxial distraction force, and the contributions of both the conoid and trapezoid ligaments are equal in this scenario.² Macroscopically, we can vouch for the fact that fibrous tissue had appeared to grow into the ligament on all occasions; however, the ligament itself still failed.

There are several studies reporting excellent clinical and radiological outcomes following coracoclavicular ligament reconstruction using LARS™, making these cases highly unusual. Among 24 patients with acute ACJ dislocation reconstructed with the LARS™ single loop technique, Lu *et al* found 4 patients with slight loss of reduction but none needed revision surgery.⁵ Fraschini *et al* compared reconstruction with a polyethylene terephthalate vascular prosthesis versus reconstruction with LARS™.⁵ In the

LARS™ group, consisting of 30 patients, there was one rupture of the neoligament and overall, the LARS™ patients had a satisfactory functional outcome with a low complication rate. In 17 patients with LARS™ reconstruction, Gianotti *et al* found no redislocation or ligament failure at the mid-term follow-up review.⁴

In a prospective comparative follow-up study, Marcheggiani Muccioli *et al* compared ACJ reconstruction using the LARS™ ligament in 22 professional and 21 non-professional athletes.¹⁵ There was a slight loss of reduction in 21% of the total patient cohort. Overall, there was no difference in clinical outcomes between the groups and there was a 2% failure rate at a minimum of two years following surgery. There was one coracoid fracture and one wound infection but no intrasubstance failure of the LARS™ ligament. A 2017 paper by Li and Woods reported failure of LARS™ reconstruction in two patients with grade V ACJ dislocation but no clear reason for this was identified.¹⁴

Looking at other techniques used in ACJ reconstruction, Singh *et al* observed failure in seven out of nine patients when the coracoclavicular reconstruction was carried out with TightRope® or GraftRope® (Arthrex, Naples, FL, US).¹⁵ In a study comparing results of the modified Weaver–Dunn procedure versus use of the Surgilig™ synthetic ligament (Surgicraft, Redditch, UK), Kumar *et al* found midsubstance failure in only 1 of the 24 patients in the Surgilig™ group.¹⁶ In a preliminary report of ACJ reconstruction using the Surgilig™ ligament in 11 patients, Bhattacharya *et al* noted a single case of rupture through the central portion of the Surgilig™ ligament.¹⁷

Although the role of synthetic ligaments in anterior cruciate ligament (ACL) reconstruction remains controversial, Gao *et al* investigated arthroscopic ACL reconstruction and came across 3 failures among 159 procedures (1.9%) using the LARS™ ligament.¹⁸ They attributed this to malpositioning of either femoral or tibial tunnels. There was a failure rate of 4.4% for ACL reconstruction using LARS™ in a study by Jia *et al*.⁹ Systematic reviews by Newman *et al*¹⁹ and Batty *et al*²⁰ reported overall rates of 2.5% and 2.6% respectively for LARS™ failure in ACL reconstruction. Again, this was generally attributed to error in tunnel placement rather than prosthetic rupture.

At the time of writing, the manufacturer's operative technique for LARS™ ligament ACJ reconstruction describes wrapping the ligament once around the coracoid process as sufficient for a primary procedure. (Personal communication from the company as no online technique published at time of report.) However, a technique for revision procedures popularised by Professor Funk in Manchester, UK, involves wrapping the ligament around twice.⁶ It is known that the success of any reconstruction depends on whether the body can heal itself before the construct fails. In the first case detailed above, there was a further injury before the fibroblastic ingrowth could have fully matured. Conversely, for the second and third patients, the coracoclavicular ligament reconstruction seemed to have failed spontaneously. In the absence of any underlying infection, this is more concerning as no obvious cause for this failure can be found.

We appreciate that this is a small case series with limitations. Nevertheless, as this is a rare occurrence, we feel it is worth sharing our experience to create awareness of a possible mode of failure of coracoclavicular ligament reconstruction with the LARS™ artificial ligament.

Conclusions

The LARS™ ligament is a valid and safe option for the treatment of acute ACJ dislocations, and it has been shown to significantly improve patients' scores for shoulder function and pain.⁵ Despite our experience, we still believe it plays a useful role in these injuries. Although the manufacturer's operative technique does not specifically state that a double loop is needed, we would suggest other surgeons consider using a double loop to avoid the complication of intrasubstance failure.

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