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Patient outcomes following arthroscopic distal clavicle excision: a prospective case series

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Background: Distal clavicle excision for acromioclavicular joint (ACJ) pathology is currently the mainstay of surgical management in patients with symptoms refractory to nonoperative treatment. There have been few high quality studies outlining the efficacy of arthroscopic excision of the distal clavicle as a single procedure in patients with isolated disease.
Aim: To characterize function and pain outcomes in patients undergoing arthroscopic distal clavicle excision by utilizing stringent inclusion criteria to isolate ACJ pathology.
Methods: Prospective data collection was undertaken with a minimum two year follow-up of 59 patients undergoing arthroscopic distal clavicle excision for ACJ osteoarthritis or distal clavicle osteolysis. Stringent eligibility criteria were applied to each patient. Data collection consisted of demographic data, clinical assessment of range of motion, and patient-reported outcome measures (PROMs), utilizing the standardized Shoulder Pain and Disability Index (SPADI) and the Visual Analogue (VAS) score to characterize pain. Furthermore, time to return to work and sport and a subjective measure of how 'normal' the shoulder felt were assessed. Data was recorded preoperatively, and at six, 12, and 24 months postoperatively. Statistical analysis was conducted utilizing institutional support.
Results: Statistically significant improvements in range of motion measurements (abduction, forward elevation and external rotation), and PROMs (SPADI and VAS scores) were reported. VAS scores reduced from an average of 8.20 preoperatively to 3.39 ($P < .001$), 2.13 ($P < .001$) and 1.36 ($P < .001$) at 6, 12, and 24 month follow-up, respectively. Similarly, SPADI scores reduced from an average of 62.65 preoperatively to 19.96 ($P < .001$), 12.6 ($P < .001$), and 6.13 ($P < .001$) at 6, 12, and 24 months, respectively. The majority of patients were able to return to sport and work, within an average time of 1.72 and 3.02 months.
Conclusion: In patients who presented with isolated ACJ pathology, arthroscopic distal clavicle excision, as a single procedure, results in statistically significant improvements in PROMs and functional outcomes.

Osteoarthritis (OA) and osteolysis (OL) of the acromioclavicular joint (ACJ) are common causes of shoulder pain in adults, with onset as early as the second decade of life. Symptoms are more common in patients who subject the joint to high loads or repetitive overhead activities, such as throwing. The mainstay of treatment is nonoperative, with a trial of oral analgesics and anti-inflammatory agents, physical therapy and intra-articular injection of corticosteroid, and local anesthetic.[3] In some patients, however, the symptoms persist despite conservative treatment. In these patients with refractory disease, open, and more recently, arthroscopic excision of the distal clavicle is becoming the mainstay of treatment.[12]

Arthroscopic excision of the distal clavicle was popularized as a surgical treatment option for ACJ arthritis and OL in the early 1990's and has largely replaced the open procedure. Although a recent

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No institutional review board approval was required for this study.

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meta-analysis and systematic review suggests similar outcomes between open and arthroscopic techniques,[9] advantages of arthroscopic technique include improved cosmesis, reduced postoperative pain, and the preservation of the superior capsule, thereby reducing the risk of postoperative instability.[14,21] Several studies published in the 1990s reported excellent pain and functional results in patients who presented with ACJ arthritis or OL who had failed an attempt of conservative management. Unfortunately, most of these studies were small case series with study populations ranging from 10-50 subjects,[10,15] they were nonrandomized, and had no control group to compare outcomes.[16] In addition, these studies failed to isolate ACJ OA or OL as a single cause of symptoms. Several of these studies included patients with previous ACJ injury and resultant instability.[7] Since then, a number of studies have been published outlining the results of distal clavicular excision in combination with another procedure. The additional procedure is often a rotator cuff repair for cuff pathology[17] or subacromial decompression for impingement syndrome.[10,13] Within the literature published to date, the investigators have failed to produce a rigorous study that provides evidence for the use of arthroscopic distal clavicular excision as a treatment modality for isolated ACJ OA or OL in the general population.

The aim of this prospective study is to determine whether arthroscopic resection of the distal clavicle is an effective procedure for management of isolated ACJ arthritis and OL, in a carefully selected patient population. To our knowledge, this study investigates the largest cohort of patients undergoing arthroscopic distal clavicular excision available in the literature to date. We hypothesize that these select patients will experience a clinically significant reduction in pain scores, an improvement in functional scores, and display greater shoulder range of motion (ROM) postoperatively.

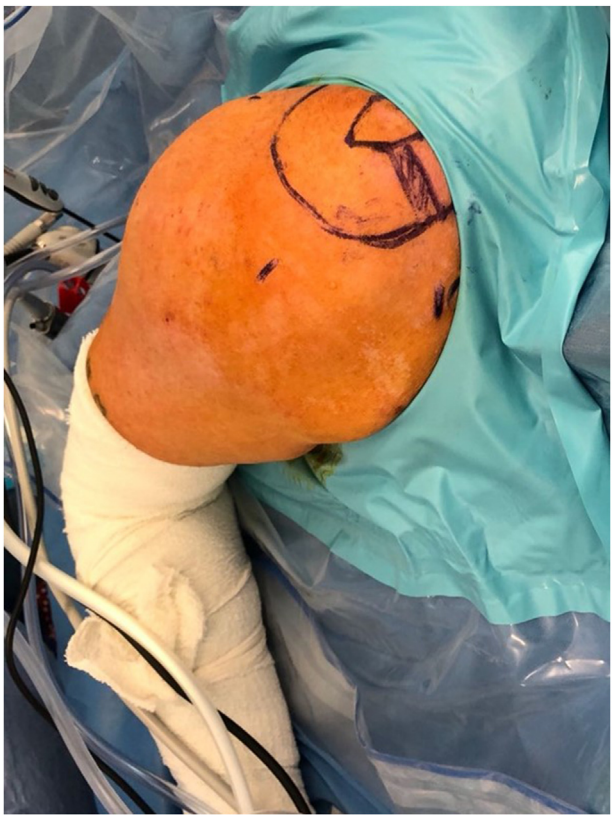

Figure 1 Intraoperative image demonstrating anterior, posterior, and bursal portal sites.

Materials and methods

Prior to commencing this study, formal ethics approval was sought from the ethics committees at Norwest and Sydney Adventist Private Hospitals, Sydney, Australia. Appropriate study candidates were identified during consultation in the lead surgeon's rooms. From August 2012 to October 2020, all patients undergoing arthroscopic distal clavicular excision for ACJ OA or OL were screened for inclusion in the study. Candidates were considered appropriate for inclusion if they fulfilled the following four criteria:

1. Pain localized to the ACJ on physical examination;
2. Pain present for greater than six months duration;
3. A positive result to corticosteroid injection into the affected ACJ; and
4. Radiological evidence of ACJ arthritis or OL on standard radiography, computed tomography, or magnetic resonance imaging.

Informed consent was obtained at time of recruitment. Each candidate underwent an arthroscopic resection of the distal clavicle performed by the primary surgeon. The patient was placed in the beach chair position with the arm free draped, 1 g cefazolin was administered at time of induction. The surgeon utilized a three portal technique: anterior, posterior, and bursal (indirect) arthroscopic portals to access the ACJ (Fig. 1). Each patient underwent an arthroscopy of the glenohumeral joint, subacromial bursectomy, and excision of the distal clavicle using a 5.5 mm burr. A maximum of 10 mm was resected from the distal clavicle; this resection distance was measured using the burr as a sizing reference. Generally, 7-8 mm of resection was enough to allow adequate clearance. Resection was performed in an inferior to superior direction, this technique allowed adequate visualization of the overlying joint capsule and avoided damage to the coracoclavicular ligaments (Fig. 2). Image intensifier was used intraoperatively to confirm adequate resection (Fig. 3). Postoperatively, the patients were placed in a shoulder immobilizer sling for comfort, and encouraged to perform early, gentle, ROM exercises, commencing day one. ROM and strengthening exercises were permitted as tolerated in the postoperative period.

Data was collected prospectively from time of preoperative initial consultation, and then at six, 12 and 24 months postoperatively. Patient-reported outcome measures (PROMs) were in the form of pain and functional scores using the Shoulder Pain and Disability Index (SPADI) and patients were asked to complete a paper based questionnaire.[20] This was combined with a physical examination performed by the treating surgeon. Examination was aimed at localizing pain and irritability to the ACJ by direct palpation and assessing shoulder ROM using a goniometer. Information regarding return to work and sport, work-cover status, whether the patient would undergo the procedure again and whether they felt that their shoulder had subjectively returned to 'normal' was also collected with a paper based questionnaire at this stage. Patients were asked to give their shoulder a subjective 'percentage of normal' score out of 100%. The outcome was considered 'excellent' if the participant had no pain, had full ROM, and had no functional limitations after surgery. A 'good' result was recorded if the patient had slight or occasional pain with no significant compromise to function, and a 'poor' result was any outcome that did not meet the above criteria.[7]

The data was also divided into two groups based on primary pathology, namely OA and OL. A comparison was made within and

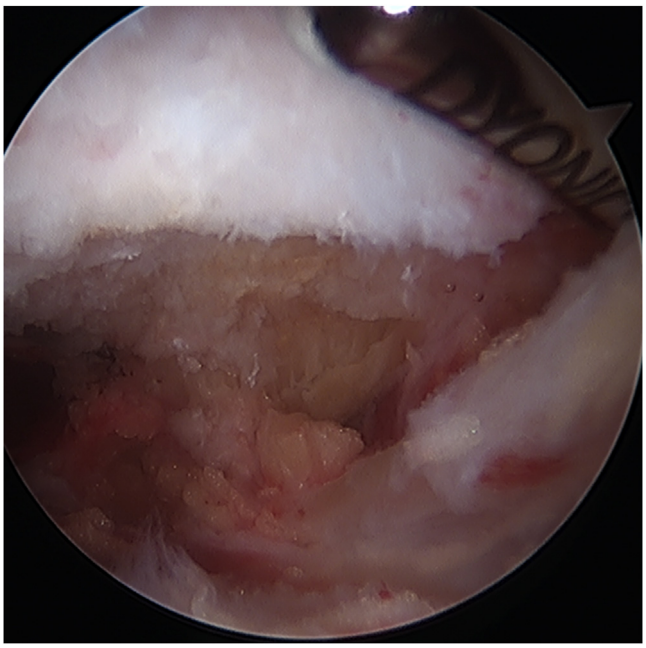

Figure 2 Arthroscopic view demonstrating clavicular resection and intact coracoclavicular ligaments.

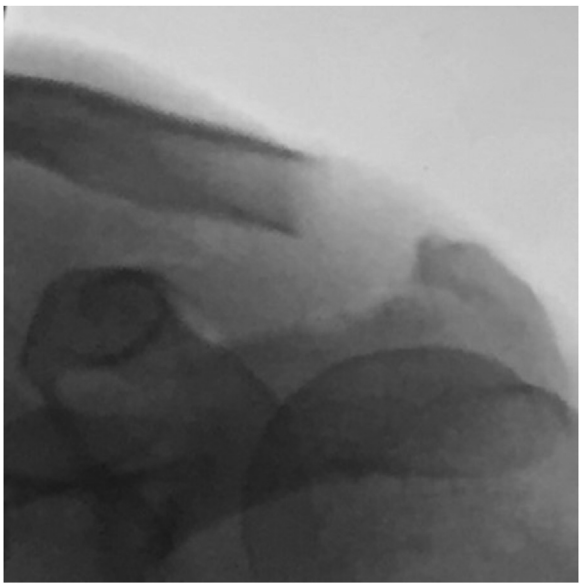

Figure 3 Image Intensifier demonstrating adequate distal clavicular resection.

between the groups to determine differences in functional outcome, and standardized scoring measures. Patients were excluded if insufficient data was available at two year follow-up. Data was summarized and presented as mean, standard deviation (symmetric normal data), median, interquartile range (skewed or ordinal data), and proportions with 95% confidence intervals. The test for the significance of the difference in variables at each period compared to the baseline preop was assessed using paired samples t-test. When the distribution of the variable was skewed, a nonparametric Wilcoxon signed-rank test was used. All the statistical tests were performed at a 0.05 level of significance. Analyses were performed in SPSS V27.0 (IBM Corp., Armonk, NY, USA).

Results

Ninety- seven patients were included in the study, enrolling from August 2012 to October 2020. Fifty-nine patients completed the study visits and were included in the statistical analysis (Fig. 4). Time to follow-up ranged from 24 months to ten years (median 5.7 years). The study population had a mean age of 53.7 years (range 25-78 years; SD 9.23). Twenty (34%) of the participants were female and 39 (66%) were male. Eighty percent of the subjects were right hand dominant, 17% were left hand dominant, with the remainder identifying themselves as ambidextrous; 37 participants (63%) underwent surgery on their dominant arm. Almost two thirds (38/59) of subjects had OA of the ACJ as a primary diagnosis, whilst the remaining 1/3 had OL of the distal clavicle as a primary diagnosis. Twenty-eight patients (47%) presented under workers compensation claims.

Clinical examination at final follow-up revealed statistically significant improvements in ROM measurements from the preoperative evaluation: for forward elevation (ELE) (154.5 vs. 171.3 degrees, $P < .001$), abduction (ABD) (141.8 vs. 163.7 degrees, $P < .001$) and external rotation (ER) (65.5 vs. 74.9 degrees, $P = .001$) (Table I).

The PROMs also showed significant improvements post-procedure. The mean pain Visual Analogue (VAS) score preoperatively was 8.20 (SD 1.36). At 6, 12 and 24 month follow-up, the mean VAS scores were 3.39 ($P < .001$), 2.13 ($P < .001$) and 1.36 ($P < .001$), respectively, demonstrating significant improvement (Fig. 5). No participants reported a higher pain score post-operatively when compared to their preoperative score.

Preoperative vs. postoperative SPADI scores showed statistically significant improvements at the 6, 12 and 24 month follow-ups, with scores of 62.65 preoperatively, and 19.96 at 6 months ($P < .001$), 12.6 at 12 months ($P < .001$), and 6.13 at 24 months ($P < .001$) (Fig. 6).

Analysis by diagnosis was also conducted by dividing patients into OA and OL sub-groups. Preoperative and postoperative clinical evaluation and PROMs were contrasted between each group. Similar improvements were observed. Preoperative and post-operative ROM measurements displayed significant improvements in both groups. A statistically significant effect was observed for all movements in the OA group, with an average improvement of 16.0 degrees ($P \leq .001$), 19.06 degrees ($P = .006$), and 10.0 degrees ($P = .006$) for forward ELE, ABD, and ER, respectively. Within the OL group, forward ELE and ABD improved on average 14.0 degrees ($P = .049$), and 13.0 degrees ($P = .030$) respectively. Improvements in ER did not reach statistical significance ($P = .056$). When the groups were compared to each other, no statistically significant difference was found ($P > .05$).

Similar improvements were seen in PROMs, with significant improvements in SPADI scores at 6, 12 and 24 months post-operatively within both groups. The OA group reported a mean difference of: 41.3 ($P \leq .001$) at 6 months, 48.0 ($P \leq .001$) at 12 months, and 58.6 ($P \leq .001$) at 24 months. The OL group reported improvements of 47.4 ($P \leq .001$) at 6 months, and 57.6 ($P \leq .001$) at 12 months, and 59.8 ($P \leq .001$) at 24 months.

VAS scores for pain displayed similar improvements at 6, 12 and 24 months postoperatively within both groups. The OA group reported a mean difference of 4.67 ($P \leq .001$) at 6 months, 5.61 ($P \leq .001$) at 12 months, and 6.80 ($P \leq .001$) at 24 months. The OL group reported improvements of 5.21 ($P \leq .001$), 6.47 ($P \leq .001$) and 7.27 ($P \leq .001$) at 6, 12, and 24 months, respectively.

Workers compensation claims made up 47.46% of our patient cohort. When this data was analyzed separately, similar outcomes were observed. PROMs showed statistically significant improvements when compared to preoperative score with a mean pain VAS

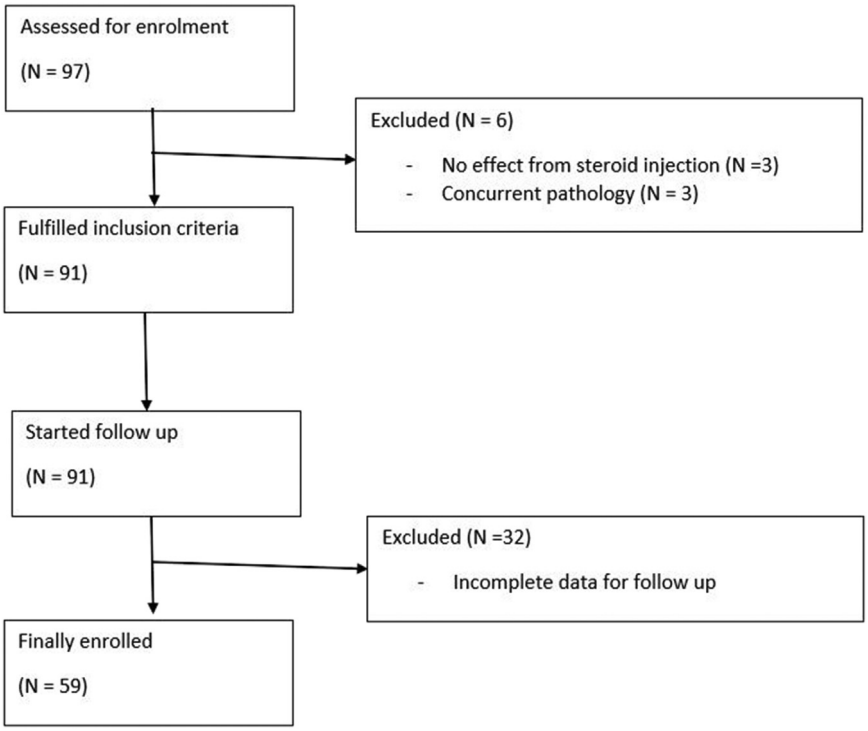

Figure 4 STROBE diagram.

Table I
Clinical outcomes at Follow-up.

ROM (degrees)	Preop	Postop	% improvement	*P* value
ELE	154.5	171.3	10.9	<.001
ABD	141.8	163.7	15.4	<.001
ER	65.5	74.9	14.4	<.001

ROM, shoulder range of motion; *ELE*, elevation; *ABD*, abduction; *ER*, external rotation; *Preop*, preoperative; *Postop*, postoperative.

of 8.31 vs. 4.13 ($P \leq .001$) and SPADI score of 66.89 vs. 28.07 ($P < .001$), respectively. In addition, no statistically significant difference ($P > .05$) was observed between the worker's compensation group and the no worker compensation group for any of the outcome variables across the time periods. Improvements in outcome scores remained consistent between the worker compensation status and no worker compensation groups, implying no significant effect modification due to worker compensation status ($P > .05$).

No participants reported being unable to return to work after the procedure, and on average, the time to return to work was 1.72 months (range 1 week-12 months, SD = 2.01). One patient was unable to return to sports postprocedure with an average return to sport time of 3.02 months (range 2 weeks-12 months, SD = 2.89). When asked to give a subjective description of how close their shoulder felt to normal, 78% reported that their shoulder felt 'completely normal', and participants reported that their shoulder was, on average, at 88% of normal function (range 20%-100%).

Four patients were found to have ongoing high pain scores (VAS > 5) at their most recent postoperative follow-up. One of these patients required a revision operation due to formation of ectopic bone and will be discussed below. The remaining three patients continue to have ongoing shoulder pain despite radiographic evidence of adequate clearance and continue to be managed expectantly. Two patients (3.4%) from our cohort required revision excision due to the formation of ectopic bone. Investigation in the form of repeat imaging was prompted by persistently high postoperative VAS scores. Revision arthroscopic excision of the distal clavicle was performed by the lead surgeon, and the patients remained in the study. One of these patients has made an excellent recovery with improvements in PROMs and ROM, the other continues to experience symptoms from their affected shoulder in the form of pain and weakness. There were no obvious cases of instability.

Discussion

Our study suggests that in carefully selected patients who meet stringent inclusion criteria, patients undergoing arthroscopic distal clavicle excision for ACJ OA or OL experience statistically and clinically significant improvements in ROM and PROMs. Currently, arthroscopic excision of the distal clavicle remains the mainstay of treatment for ACJ OA and OL once nonoperative measures have failed. To date, there have been a number of studies aimed at evaluating the efficacy of arthroscopic distal clavicular excision. Unfortunately, these studies are primarily composed of small case series, with lax inclusion criteria, which often fail to adequately isolate pathology specific to the ACJ. Ringshawl et al have recently published on the largest cohort in the literature to date, examining 50 patients in their prospective series.[19]

In 1995, Snyder et al published a retrospective review investigating the effect of arthroscopic distal clavicle excision in 50 symptomatic ACJs.[24] The investigators reported "excellent" or "good" scores in most of their patients, with the majority of patients being able to return to work and sport at their premorbid level (89%). Despite being of reasonable size, ACJ pathology was not isolated and patients underwent a number of different procedures at time of surgery, including management of intra-articular glenohumeral joint pathology, and subacromial decompression. Preoperative and perioperative analgesia regimens were varied, and clavicular resection ranged from 7 to 20.5 mm.[24]

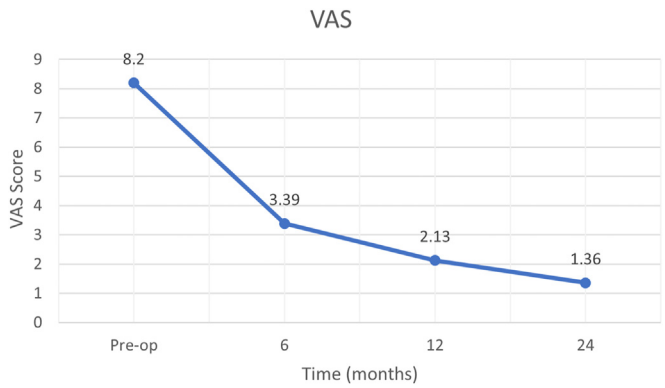

Figure 5 VAS vs. Time at follow-up. *VAS*, visual analogue scale.

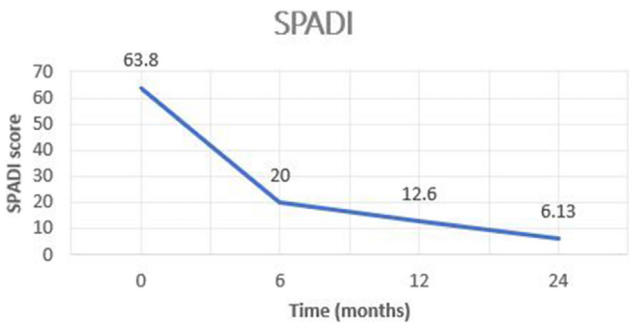

Figure 6 SPADI score vs. time at follow-up. *SPADI*, shoulder pain and disability index.

Drawing conclusions from early systematic reviews and meta-analyses is difficult. These studies aimed to determine superiority of arthroscopic compared to open techniques for distal clavicle resection. The poor quality evidence included in the reviews made it impossible to perform meta-analysis and the results were often inconclusive.[16]

In 2007, Rabalais and McCarty published a systematic review that aimed to investigate the effect of any method of surgical management for ACJ pathology.[16] A section of this paper was dedicated to isolated arthroscopic excision of the distal clavicle for management of distal clavicular OL or ACJ arthritis. Participant numbers in the reviewed articles were low (10-42 subjects),[1,2,11] and follow-up duration ranged from 1.2 to 6.2 years.[11,26] Although all studies reported good or excellent results, they utilized varying scoring systems,[8,25] varying surgical techniques, and lax inclusion criteria. Due to the heterogeneity of the included studies, the authors of the review were unable to run the statistical analysis required for a meta-analysis.[16] Pensak et al published a systematic review in 2010 with similar aims.[14] Despite similar difficulties die to methodology of included studies, the authors concluded that with a direct, arthroscopic, resection of the distal clavicle for ACJ arthritis or OL, patients could expect a faster return to activities whilst obtaining similar long-term outcomes when compared to an open procedure.[14]

Hohmann and colleagues published a systematic review and meta-analysis also comparing the efficacy of open vs. arthroscopic excision of the distal clavicle.[9] The pooled results demonstrated no significant differences between open and arthroscopic resection.

Also in 2007, Charron et al[4] published a prospective case series focused on arthroscopic distal clavicle resection in 34 athletes. The paper aimed to compare differences between the indirect vs. direct arthroscopic technique as a means of operative management for posttraumatic ACJ arthrosis or OL. Participants who had failed to improve following 4-6 months of conservative management (consisting of NSAIDs, ACJ injections of local anesthetic, and physical therapy) were then randomized into direct and indirect groups. In an attempt to isolate pathology to the ACJ, all patients underwent a magnetic resonance imaging scan to rule out other injuries and no procedure other than distal clavicle excision was performed. Participants had 8-10 mm of distal clavicle resected using either the direct or indirect technique. The direct technique utilized anterior and posterior portals for access to the joint, whilst the indirect technique utilized posterior subacromial, anterior and lateral portals. Charron's article reported improved clinical outcomes at 27 months in keeping with earlier studies. Their main finding was that the direct approach provided favorable functional outcome scores at early follow-up (2 and 6 weeks) with earlier return to sport in these athletes. The article by Charron et al[4] remains one of the few prospective case series published in the literature.

By utilizing strict inclusion and exclusion criteria and focusing the operative technique on known pathology only, our study allows more accurate prediction of postoperative outcomes in this subset of patients. In general, the most common preoperative complaint in this patient demographic is pain that limits function. Importantly, based on our findings, we are now able to tell patients that most people will experience a significant improvement in pain and function, with 81% of patients reporting a VAS score ≤ 3 at final follow-up. The reported Minimal Clinically Important Difference for numeric pain scores in chronic musculoskeletal pain is 15%; therefore, the reduction in pain reported in our study population likely represents significant clinical improvement.[23] Similarly, the Minimal Clinically Important Difference for the SPADI score has been reported as 18 points, adding clinical relevance to our findings.[22] Finally, patients undergoing this procedure are likely to return to work (including physical work) within three months of their operation.

There does, however, appear to be a subset of the population ie, unlikely to improve. There were four patients (6.8%) in our study who reported poor pain outcomes. The two patients who underwent a revision procedure were found to have either a bony spur, or ectopic bone, on repeat imaging. Revision surgery was in the form of repeat arthroscopic resection with an on table image intensifier image to ensure no remaining bone. Patients, who had no clear cause of their ongoing pain, on clinical and radiological evaluation, underwent repeat steroid injection and gentle physiotherapy. It is important for any surgeon who is considering operative management to be aware that there are patients who are unlikely to improve following a distal clavicular excision, and the challenge that remains is how to identify these patients preoperatively.

The most common postoperative complication in our patient population was a residual bony spur, or ectopic bone formation. This finding is reflected in the literature, with reports of asymptomatic secondary ossification in up to 25% in postoperative patients having undergone an ACJ resection.[10,24] Two patients (3.4%) in our series were found to have residual bony spurs under the distal clavicle on repeat imaging associated with localized pain. These patients were symptomatic throughout their postoperative follow-up period, with minimal improvement in their pain and function. There were no variations in management regimens for these patients compared to the remainder of the cohort. Both patients underwent a revision procedure, one of which has had excellent results postrevision, reporting a VAS score of zero at the two year follow-up. Ectopic bone formation has previously been identified as a potential complication associated with distal clavicular excision. In an article published by Charron et al (2007)[4], ectopic bone formation was the only complication reported in their cohort of 34 athletes undergoing arthroscopic distal clavicle excision for posttraumatic OL or arthritis of the ACJ. The affected patient in the Charron study underwent a revision procedure but was unable to return to sport. We suggest that any patient with ongoing

pain should undergo repeat radiographic investigation. Furthermore, patients with symptomatic heterotopic ossification, or residual bone from incomplete clearance, confirmed on clinical and radiological examination should proceed to revision operation.

Another documented complication of distal clavicular excision is ACJ instability postoperatively, particularly if the patient has associated preoperative ACJ ligamentous injury.[7] In our cohort, we have had no reports of ACJ instability, or neurovascular injury. There is no clear consensus in the literature regarding the exact amount of distal clavicle resection required to achieve symptomatic relief from ACJ pathology, whilst maintaining the stability of the joint. However, both cadaveric and clinical studies support that the resection length used in this study, namely 10 mm, will provide adequate pain relief,[5,18] whilst maintaining the integrity of the nearby coracoclavicular ligaments,[6] with these ligaments being the primary biomechanical stabilizers of the ACJ.

To our knowledge, this study is the largest prospective patient cohort study investigating the role of distal clavicular excision for ACJ OA and OL. It is the only study to adhere firmly to the clearly outlined inclusion and exclusion criteria, in which the patient cohort undergoes a procedure specific to the documented pathology. There are, however, limitations in our study design. This trial did not have a control group, and it was not randomized into treatment arms, and a power calculation was not conducted prior to commencing data collection. Furthermore, although the recruitment period spans eight years, the most recent patients to undergo surgery have a follow-up period limited to two years. This long recruitment period may have contributed to the large number of patients who were lost to follow-up (38 of 97), as all patients with an incomplete data set were excluded from the study. This was unfortunately often due to that the patient had relocated. Although it was important to the investigators to adhere to simple diagnostic criteria, radiological grading of the severity of pathology may help with prognostication. Longer term results will add to our understanding of long term recovery. Therefore, scope remains to provide a higher level of evidence in the future.

Conclusion

In carefully selected patients who meet four stringent inclusion criteria, participants undergoing arthroscopic distal clavicle excision for ACJ OA or OL are likely to experience statistically and clinically significant improvements in ROM and PROMs. To our knowledge, this study investigates the largest cohort of patients undergoing arthroscopic distal clavicular excision, with the longest follow-up time, available in the literature to date.

Disclaimers:

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