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ORIGINAL ARTICLE

Minimum 2-year outcomes and return to sport following resection arthroplasty for the treatment of sternoclavicular osteoarthritis

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Hypothesis: The aim of this study was to assess the effect of open resection arthroplasty for osteoarthritis of the sternoclavicular (SC) joint on pain levels, functional outcomes, and return to sport.
Methods: Patients from a single surgeon's practice who underwent open resection arthroplasty (maximum 10-mm resection) for SC osteoarthritis or prearthritic changes between November 2006 and November 2013 were retrospectively reviewed. This was an outcomes study with prospectively collected data. Preoperative and postoperative American Shoulder and Elbow Surgeons score, Quick Disabilities of the Arm, Shoulder, and Hand score, Single Assessment Numeric Evaluation score, several pain scores, and level of sport intensity were assessed.
Results: Seventeen SC joints in 16 patients (9 female, 7 male) met inclusion criteria. Mean age at time of surgery way 41.1 years (range, 12-66 years). One patient refused participation in the study. Three SC joint resections (17.7%) required SC joint revision surgery. Minimum 2-year outcomes data were available for 11 of the remaining 13 SC joints (84.6%). The mean time to follow-up was 3.3 years (range, 2.0-8.8 years). Pain at its worst ($P = .026$), pain at competition ($P = .041$), the Quick Disabilities of the Arm, Shoulder, and Hand score ($P = .034$), and the ability to sleep on the affected shoulder ($P = .038$) showed significant improvement postoperatively. The average postoperative American Shoulder and Elbow Surgeons score was 83.3. The level of sports participation ($P = .042$) as well as strength and endurance when participating in sport ($P = .039$) significantly increased postoperatively.
Conclusion: Resection arthroplasty of the medial end of the clavicle in patients with osteoarthritis of the SC joint without instability results in pain reduction, functional improvement, and a high rate of return to sport at midterm follow-up.
Level of evidence: Level IV; Case Series; Treatment Study

Keywords: Sternoclavicular joint; open; resection arthroplasty; osteoarthritis; outcomes; return to sport

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Injuries of the sternoclavicular (SC) joint are rare and usually caused by high-energy mechanisms, such as collision sports or motor vehicle accidents.[11,20,22] Until the mid-1990s, most symptomatic conditions of the SC joint refractory to conservative management were treated with resection arthroplasty.[2,3,5,8,15,19,28] With increasing awareness that SC joint resection for instability following anterior and posterior SC joint dislocation resulted in poor outcomes, the treatment of disorders of the SC joint became more differentiated.[20] Symptomatic instability of the SC joint is best treated with surgical ligament reconstruction, whereas stable conditions with degenerative SC joint disease can be successfully treated with resection arthroplasty.[1,7,11,12,16-18]

In the past 20 years, there have been limited studies reporting outcomes of SC joint resection arthroplasty. Most of these reports include mixed operative indications and varying amounts of medial clavicle resection, ranging from 1 cm up to 4 cm.[1,2,7,12,16,18,21,23,24,27] Recent anatomic and biomechanical studies have suggested that minimizing bone resection in performing SC joint resection arthroplasty may be advantageous for preservation of ligamentous joint stabilizers.[9,10,14] Although functional improvement has been reported following SC joint resection for osteoarthritis, the effect on return to sports in active patients remains unknown from published literature.[2,12,18,22,24,27] The purpose of this study was therefore to assess functional outcomes and return to sport following resection arthroplasty for osteoarthritis of the SC joint, with a maximum resection of 10 mm. Significant improvements in functional outcome scores and high rates of return to sport were hypothesized.

Materials and methods

Patients who underwent SC resection arthroplasty and who were living in the United States with minimum 2-year follow-up were included in this study. Between November 2006 and November 2013, open resection arthroplasty was performed in 18 SC joints (17 patients) for painful osteoarthritis (n = 14) or painful prearthritic changes with chondral lesion and tear of the intra-articular disk (n = 4) without instability by a single surgeon. All patients had undergone an unsuccessful period of nonoperative management with nonsteroidal anti-inflammatory medication and physical therapy of at least 3 months. For preoperative planning, radiographs (Fig. 1) and a computed tomography or magnetic resonance imaging scan (Fig. 2) were obtained to assess the morphology of the SC joint and to define the closely related vascular structures.[10,11,20,26] An infectious cause of the SC joint arthritis was ruled out in all patients.[1,7]

Surgical technique

The patients were placed supine on the operative table under general anesthesia. The entire chest, including both SC joints, was prepared for optimal anatomic and topographic orientation. A skin incision approximately 5 cm in length was made, beginning directly above the medial aspect of the clavicle and extending at the anterior-superior aspect of the sternum. The overlying soft tissues and sternocleidomastoid tendon were protected.[10] A longitudinal incision was then made through the anterior SC joint capsule. The anterior capsule was then dissected with the periosteum off the medial portion of the clavicle.

The costoclavicular ligament was preserved to maintain SC joint stability (Fig. 3). Blunt retractors were placed to protect the soft tissues and neurovascular structures cephalad and posterior to the medial clavicle. A maximum of 10 mm of the medial clavicle was resected with an oscillating saw parallel to the SC joint line (Fig. 4). Whereas the anterior-inferior portion of the medial clavicle was the main articulating part within the SC joint and was included in the resection, the amount of resection of the medial clavicle was always limited to a maximum of 10 mm to preserve the ligamentous joint stabilizers, particularly the costoclavicular ligament.[4,6,10,14,25] Lee et al showed that the costoclavicular ligament attaches approximately 12 mm lateral to the SC joint.[10]

To ensure protection of the main vessels posterior to the SC joint, the posterior SC joint capsule was protected throughout the procedure. The final resection plane was smooth, with the resected medial clavicle carefully contoured with a rongeur and bone rasp. The intra-articular disk was also completely resected. The medial end of the clavicle was sealed with bone wax to prevent bleeding and heterotopic bone formation, and the wound was copiously irrigated (Fig. 5).

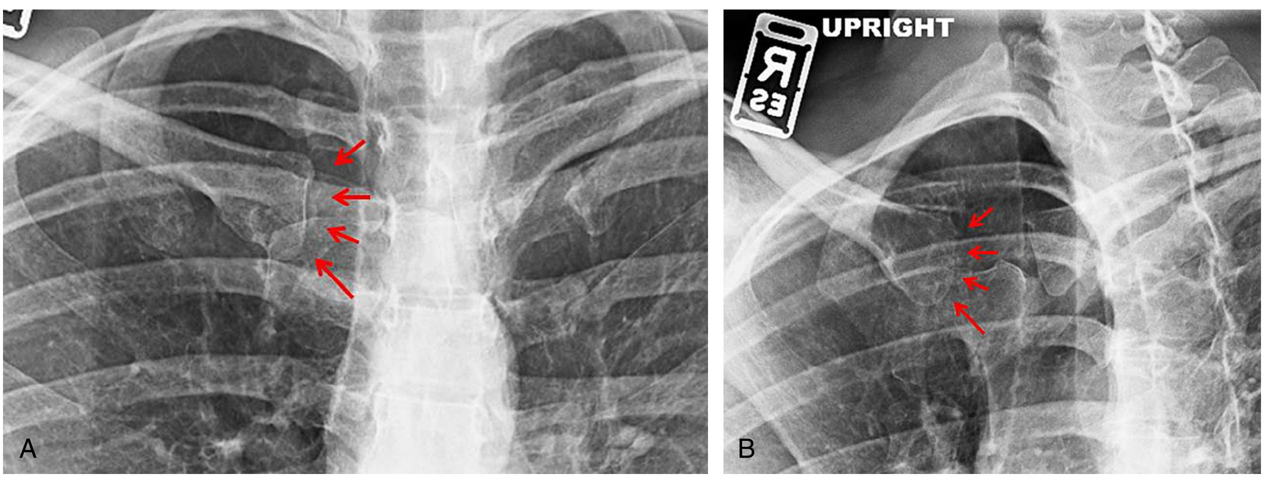

Figure 1 (**A** and **B**) Post-traumatic osteoarthritis of the right SC joint (*arrows*); 24-year-old male patient.

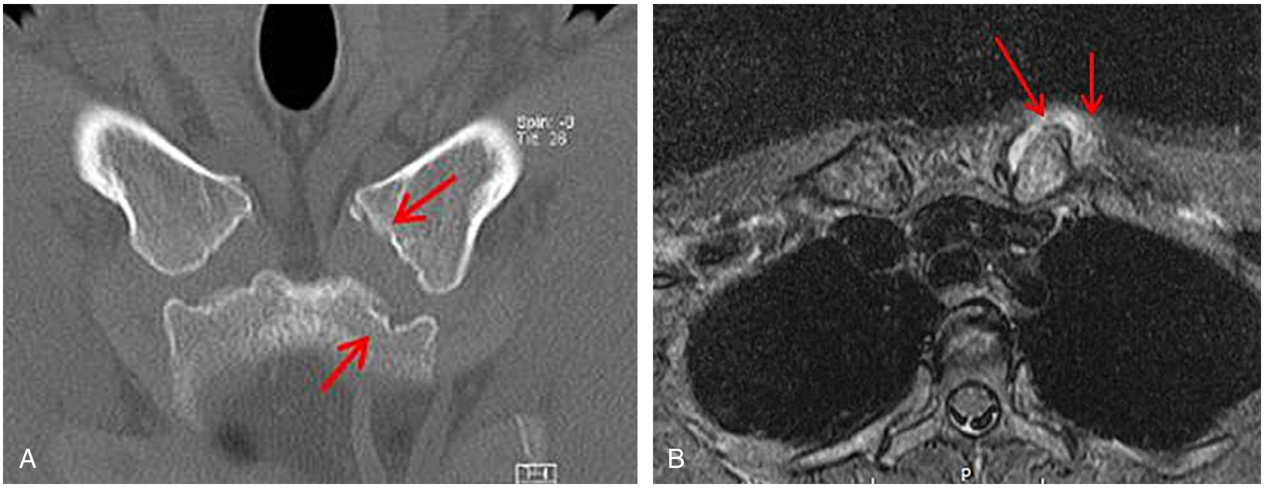

Figure 2 (**A**) Bilateral osteoarthritis of the SC joints, computed tomography scan, coronal plane; 24-year-old male patient. Notice the subchondral cysts that are present on both sides of the joint (*arrows*). (**B**) Axial magnetic resonance imaging (T2) of the chest in a 38-year-old woman demonstrating osteoarthritis of the left SC joint. Notice the increased signal intensity in the joint and periarticular soft tissues (*arrows*).

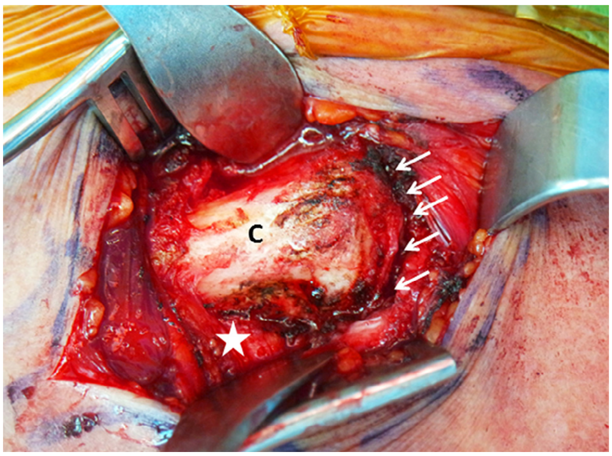

Figure 3 Right SC joint: exposed medial clavicle (*C*) and right SC joint (*arrows*) after longitudinal incision of the anterior capsule with preservation of the costoclavicular ligament (*star*).

Stability of the SC joint was assessed manually before and after resection of the medial end of the clavicle to rule out instability. In cases in which there is instability, a figure-of-8 allograft reconstruction would be recommended.[11,17] Such cases were not included in this study. The decompression was also assessed by axially loading the clavicle while palpating the SC joint. To improve stability after SC joint resection, the anterior capsule and periosteum were closed firmly with figure-of-8 sutures (No. 1 Vicryl; Fig. 6). Care was taken to preserve the sternocleidomastoid tendon. Finally, the wound was closed in a layered fashion, a soft dressing was applied, and the operative arm was placed in a sling.

Postoperative rehabilitation

Early passive motion was initiated and encouraged in the immediate postoperative period. Active and active assisted motion began at approximately 1 to 2 weeks postoperatively, and a sling was used for the first 2 weeks for comfort. The patients were then allowed a gradual return to normal activities as tolerated.

Outcomes assessment and analysis

This was a retrospective outcomes study with prospectively collected data. Outcomes were assessed with questionnaires preoperatively and at a minimum of 2 years postoperatively. Preoperative and postoperative function levels were assessed with the American Shoulder and Elbow Surgeons (ASES), Quick Disabilities of the Arm, Shoulder, and Hand, and Single Assessment Numeric Evaluation scores as well as with questions on ability to sleep on the side.

Preoperative and postoperative pain levels were assessed with the visual analog scale (VAS) score for pain today and VAS score for pain at its worst as well as with questions on pain affecting activities of daily living and pain with competition. VAS pain scores were measured on a scale of 0-10 points with 0 = no pain and 10 = very bad pain.

Preoperative and postoperative sport levels were assessed with 3 questions: grade of participation in sport, strength and endurance when participating in sport, and intensity effort during participation in sport. The question on grade of participation in sport contained answer choices that were relative to preinjury level: (1) above or equal to, (2) slightly below, (3) moderately below, (4) significantly below, (5) cannot compete in usual sport, and (6) cannot compete in any sports. Answer choices 1 to 3 were judged to qualify as return to sport.

Patients who progressed to SC joint revision surgery were considered failures and were excluded from the final outcome analysis. The results of the functional outcome scores were normally distributed and were compared with the paired sample *t*-test. Categorical data were compared with the paired Wilcoxon signed rank test.

Results

One patient not living in the United States was excluded from the study. The remaining 17 SC joints in 16 patients (9 female,

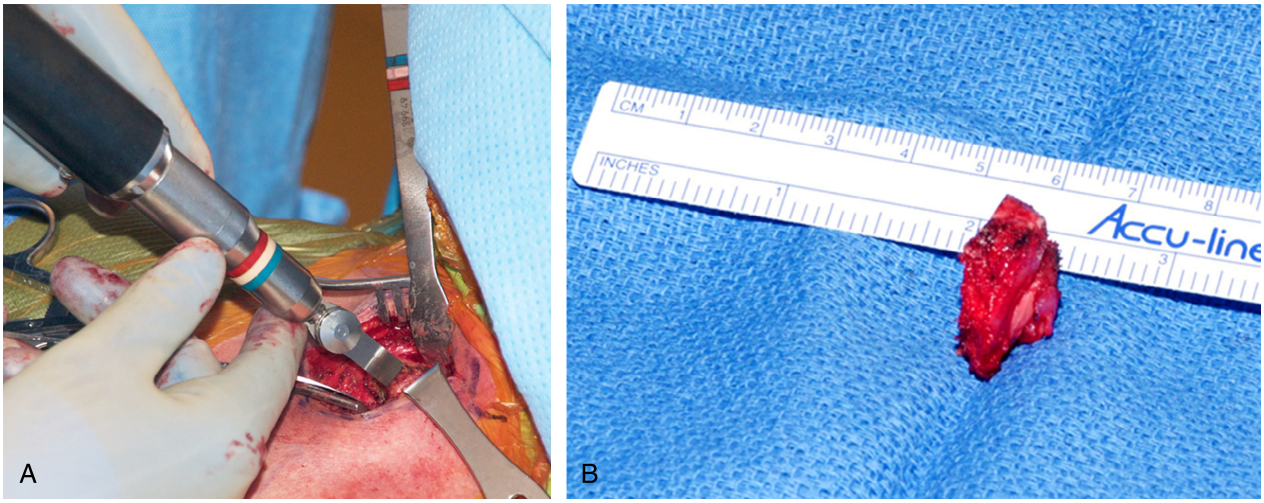

Figure 4 (**A** and **B**) Resection of a maximum of 10 mm of the medial end of the clavicle with an oscillating saw (in this case, approximately 8 mm); blunt retractors were placed to protect the soft tissues and neurovascular structures cephalad and posterior to the medial clavicle.

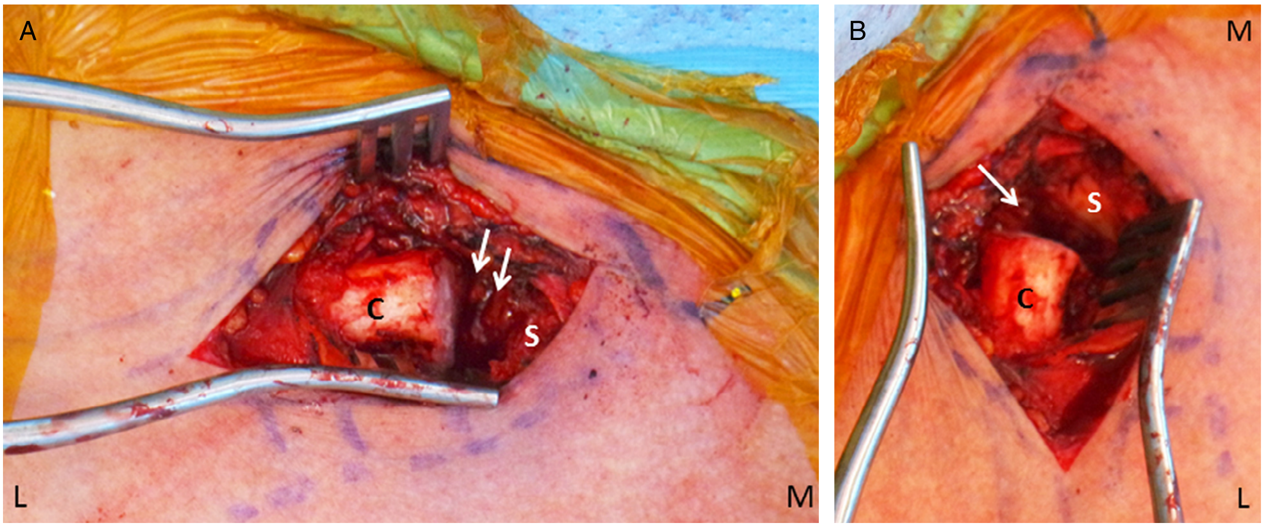

Figure 5 (**A** and **B**) Decompressed SC joint (*arrows*) after resection of approximately 8 mm of the medial clavicle (*C*). *S*, sternum; *L*, lateral; *M*, medial.

7 male) met inclusion criteria. Mean age at time of surgery was 41.1 years (range, 12-66 years). One patient (1 SC joint) refused participation in the study. Three patients/SC joints (17.7%) were considered failures as they required additional SC joint surgery: (1) a 14-year-old female patient had a revision resection of the medial clavicle 6 months after the primary resection for persistent symptoms following a contact injury on the operative shoulder while playing basketball; a supplementary 4- to 5-mm revision resection of the medial clavicle was performed in addition to the initial 6-mm resection; (2) a 49-year-old male patient developed secondary traumatic SC joint instability and had a figure-of-8 graft stabilization 10 months after the initial SC joint resection; and (3) a 62-year-old female patient with recurrent symptoms had a revision resection of the medial clavicle with osteophyte and scar tissue removal 31 months after initial SC joint resection.

Functional outcomes

Minimum 2-year outcomes data were available for 11 of the remaining 13 SC joints (84.6%). The mean time to follow-up was 3.3 years (range, 2.0-8.8 years). The Quick Disabilities of the Arm, Shoulder, and Hand score ($P = .034$) and ability to sleep on the side ($P = .038$) improved significantly postoperatively (Table I). All other functional outcome scores improved from preoperatively to postoperatively without significant differences (Table I). Median patient satisfaction was 9 of 10.

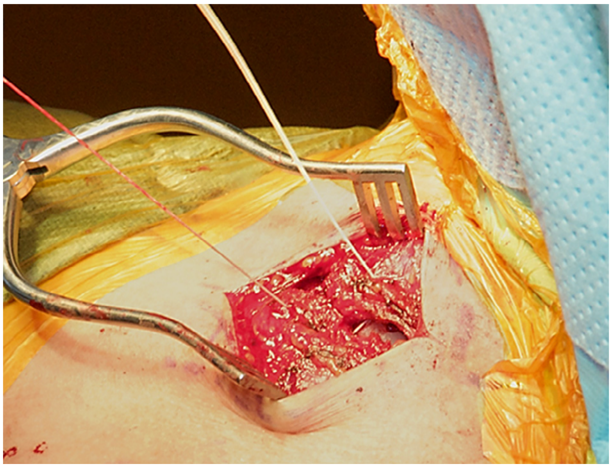

Figure 6 Closure of the anterior capsule and periosteum of the medial clavicle with figure-of-8 sutures.

Table I Comparison of preoperative and postoperative functional outcome parameters

Functional measures	Preoperative	Postoperative	Significance
QuickDASH	43.1 ± 13.7	15.2 ± 12.2	*P* = .034*
ASES score	56.8 ± 14.2	83.3 ± 14.6	*P* = .181
SANE	62.3 ± 22.9	79.7 ± 22.0	*P* = .245
Ability to sleep on side	0.5 (0-1)	2.0 (0-3)	*P* = .038*
Patient satisfaction	—	9.0 (3-10)	—

QuickDASH, Quick Disabilities of the Arm, Shoulder, and Hand; *ASES*, American Shoulder and Elbow Surgeons; *SANE*, Single Assessment Numeric Evaluation.
Standard outcome scores are reported as mean with standard deviation. Ability score (0 = unable, 1 = very difficult, 2 = somewhat difficult, 3 = normal) is reported as median with range.
* Indicates a significant difference.

Table II Comparison of preoperative and postoperative pain outcome parameters

Pain measures	Preoperative	Postoperative	Significance
VAS score for pain today	4.5 (1-7)	2.0 (0-4)	*P* = .115
VAS score for pain at its worst	9.0 (5-10)	4.0 (0-8)	*P* = .026*
Pain affecting activities of daily living†	2.0 (1-3)	1.0 (0-2)	*P* = .054
Pain with competition#	6.0 (5-6)	4.0 (1-6)	*P* = .041*

VAS, visual analog scale. VAS pain scores were measured on a scale of 0-10 points (0 = no pain; 10 = very bad pain).
All pain scores are reported as median with range.
* Indicates a significant difference.
† Pain scores on a scale of 0 = none, 1 = mild, 2 = moderate, 3 = severe.
# Pain with competition scale were: (1) no pain, (2) Pain only after competition, (3) Mild pain with competition, (4) Moderate pain with competition, (5) Severe pain with competition, and (6) Pain prevents competition.

Table III Return to sport in the 9 patients with SC joint resection who answered the question

Age	Gender	Sport	Return to sport
66	M	Mountain biking	Yes
44	F	Horse riding	No
61	F	Weightlifting	Yes
21	M	Basketball	Yes
38	F	Rock climbing, plyometrics	Yes
12	M	Baseball	Yes
55	M	Weightlifting	No
56	M	Weightlifting	No
24	F	Swimming, triathlon	Yes

Table IV Comparison of preoperative and postoperative sport level measures for patients who answered the questions

Sport level measures	Preoperative	Postoperative	Significance
Grade of participation in sport	6.0 (3-6)	2.5 (1-5)	*P* = .042*
Strength and endurance when participating in sport	5.0 (3-6)	3.0 (1-4)	*P* = .039*
Intensity effort during participation in sport	6.0 (3-6)	3.0 (1-4)	*P* = .040*

All scores are reported are median values with range.
* Indicates a significant difference.

Pain outcomes

VAS score for pain today did not significantly improve postoperatively ($P = .115$), whereas VAS score for pain at its worst and pain affecting ability to compete significantly improved postoperatively ($P = .026$ and $P = .041$, respectively). Pain affecting activities of daily living improved postoperatively without reaching statistical significance ($P = .054$; Table II).

Return to sport

Ten patients (77%) had a self-reported history of previous sport activity with involvement of the injured shoulder/SC joint. Nine patients answered the question on grade of participation in sports relative to their preinjury level, and 6 of 9 (66.7%) were able to return to sport as qualified in this study (Table III). Overall, median participation in sport improved significantly from “cannot compete in sports” to “able to compete significantly below preinjury level" ($P = .042$; Table IV). Strength and endurance ($P = .039$) as well as intensity effort during participation in sport ($P = .040$) significantly improved postoperatively (Table IV).

Discussion

In accordance with the hypothesis, open resection up to a maximum of 10 mm of the medial end of the clavicle in patients with osteoarthritis and prearthritic changes of the SC joint resulted in improved functional outcome scores, reduced pain, and may allow a return to sport.

In the past 20 years, only 5 case series with outcomes after SC joint resection for osteoarthritis have been published.[2,12,18,22,24,27] In 1 of these papers, the medial clavicle resection was combined with interposition of the medial head of the sternocleidomastoid into the SC joint.[12] In 2 others, outcomes of patients with different indications, including instability, were reported collectively.[2,22] The 2 remaining studies included only patients with SC resection of osteoarthritic joints and reported outcomes of small cohorts including 8 and 10 patients, respectively.[18,24] In both of these studies, the Rockwood score and the Constant score were assessed. Given the paucity of outcomes data among a widely variable patient population, comparison of outcomes previously reported in the literature with the results of our study is almost impossible.

Pingsmann et al found significant improvements of the Rockwood and Constant scores in 8 female patients (mean age, 54 years) following open SC joint resection. Their cohort demonstrated a mean postoperative Constant score of 87 points and a mean postoperative Rockwood score of 12.5 points at an average of 31 months postoperatively.[18] Recently, Tytherleigh-Strong and Griffith found similar results in 10 patients (7 female, 3 male; mean age, 53 years) an average of 28 months after arthroscopic SC joint resection (median Constant score, 83 points; median Rockwood score, 13.5 points).[24] The results of our study can be considered to be similar as results were found with improvements in both pain and function.

Another similarity of the 2 previously mentioned studies with ours is that the resection of the medial end of the clavicle was limited to a maximum of 10 mm. There are strong arguments in favor of limiting the amount of bone resection of the medial end of the clavicle to preserve SC stability.[6,9,10,13,14,25] Anatomic studies such as the quantitative anatomic analysis by Lee et al showed the locations of the various ligamentous attachment sites, and clinical studies have shown that resection of >10 mm (up to 4 cm) of the medial clavicle or resection in cases of SC joint instability resulted in uniformly poor outcomes.[2,8,10,16,21] Two of 3 revision surgeries in this series were related to secondary traumatic events. Nonetheless, we emphasize the importance of manually assessing stability of the SC joint as well as performing an adequate resection of the medial end of the clavicle intraoperatively.

Current case reports and 1 case series of arthroscopic SC joint resection demonstrated good to excellent clinical outcomes following resection of 6 to 10 mm of the medial end of the clavicle parallel to the joint line.[23,24,27] Future comparisons of open vs. arthroscopic SC joint resection should help determine if one of the techniques results in higher patient outcome scores than the other.

Three patients who required revision surgery were considered failures in this study. Whereas an 18% failure rate seems high, it has to be noted that 2 of these 3 failures were caused by secondary adequate traumatic events in patients who were asymptomatic and had returned to full activity before their second symptomatic period. Only 1 failure (5.9%) was caused by recurrent symptoms without traumatic onset.

This study has several limitations. Because it is a rare condition and the number of patients included were relatively small for a level IV case series, a control group for comparison was not feasible. Furthermore, no SC joint–specific or disease-specific outcome scores were assessed. The functional outcome measures used in this study are more general shoulder scores that, although validated, take into account the entire shoulder and periscapular region. One strengths of this study is that it is among the largest series of SC joint resection for osteoarthritis. Furthermore, this study is among the first to look at return to sport as well as to evaluate patient outcomes following this procedure with subjective functional outcomes scores.

Conclusions

Resection arthroplasty of the medial end of the clavicle in patients with osteoarthritis of the SC joint without instability results in pain reduction, functional improvement, and may allow a return to sport at midterm follow-up.

Disclaimer

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