

Long-term outcome after joint reconstruction or medial resection arthroplasty for anterior SCJ instability

Martin Panzica · J. Zeichen · S. Hankemeier ·
R. Gaulke · C. Krettek · M. Jagodzinski

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Abstract

Introduction In the present study, the long-term results of 11 patients with anterior sternoclavicular joint (SCJ) instability are reported. All included patients had an anterior SCJ instability and due to delayed diagnosis, operative treatment was not done immediately.

Method The patients had a mean age of 29.2 years (range 16–63 years). One patient sustained concomitant injuries. Six patients had resection arthroplasty. Five patients had reconstruction of the SCJ with transosseous tension band PDS fixation or ligament reconstruction with additional wire cerclage. The results of treatment were evaluated after a mean follow-up period of 9.9 years (range 1–27 years) using the ASES, DASH and power-, age and gender adjusted Constant–Murley Score.

Results In general, the mean values of the different scores (ASES 79.8; DASH 11.8; Constant–Murley 81%) demonstrated good outcome. The outcome evaluation of the patients who had SCJ reconstruction did not differ significantly from the patients who had medial resection arthroplasty. The rate of postoperative pain or instability was low using visual analog scale and did not differ significantly between the groups. The outcome results of the reconstruction group were equal to the results of the resection group when SCJ-reconstruction was performed soon after SCJ injury. One patient in the resection group (6 patients) demonstrated poor results due to continued instability of the remaining clavicle.

Conclusion We concluded that patient selection and a specific clinical indication for operative treatment are crucial. Resection of the medial clavicle results in good functional outcome when the costoclavicular ligament is preserved or reconstructed.

Keywords Sternoclavicular joint dislocation · Sternoclavicular joint instability · Resection arthroplasty · Sternoclavicular reconstruction · Sternoclavicular joint injury

Introduction

Injuries to the sternoclavicular joint (SCJ) are rare, compromising 3% of all shoulder girdle injuries. This type of joint injury mainly occurs after high-energy trauma caused by motor vehicle crashes and sports injuries [11, 30, 35].

Diagnosis and management of SCJ instability can be difficult. Many orthopedic surgeons have limited personal experience with these injuries [10, 40]. In the presence of associated major injuries, a SCJ dislocation may be overlooked.

Optimal treatment of the sternoclavicular injury requires precise knowledge of its developmental anatomy, an understanding of the mechanisms of dislocation and the ability to analyze radiographs in combination with the clinical examination [10, 15, 26].

The treatment of traumatic and degenerative lesions which affect the sternal articulation of the shoulder girdle continue to be controversial [14, 40].

Many of operative procedures for the treatment of an unstable SCJ have been described by numerous authors [2, 3, 7, 8, 30, 35, 37].

M. Panzica (✉) · J. Zeichen · S. Hankemeier · R. Gaulke ·
C. Krettek · M. Jagodzinski
Department of Trauma Surgery, Hannover Medical School,
Carl-Neuberg-Str. 1, 30625 Hannover, Germany
e-mail: panzica.martin@mh-hannover.de

Anatomy of SCJ

For reliable operative treatment of injuries to the SCJ, an exact knowledge of its anatomy and function is crucial [19]. The clavicle is the first long bone to start to ossify (fifth embryonal week); however, the medial epiphysis may not fuse until 22–25 years of age. Physeal disruptions may mimic sternoclavicular dislocations [35].

The SCJ is the only diarthrodial articulation between the upper extremity and the axial skeleton [32]. Almost every movement of the upper limb involves the SCJ. It is functionally a ball and socket joint. However, there is little osseous stability because less than half of the medial clavicular surface articulates with the sternal surface of the proximal manubrium. An intraarticular fibrocartilagenous disc compensates for the joint incongruity [21, 32, 39, 40].

The complex of stabilizing ligaments of the SCJ includes the interclavicular ligament, the anterior and posterior sternoclavicular ligament, and the costoclavicular ligament.

The anterior and posterior sternoclavicular ligaments provide stability in the horizontal plane while the costoclavicular ligament is responsible for stability in the frontal plane of the joint and limits upward movements [32, 39].

Functionally, the SCJ is one of the most mobile joints in the body with motion in all planes. During elevation, flexion and extension the clavicle can pass through a 35° arc of motion. The clavicle can rotate around its axis a maximum of 45° [32].

Pathogenesis and classification of SCJ Injuries

Dislocations of the SCJ result either from direct or from more commonly indirect trauma mechanisms and are classified as anterior or posterior types (relation 20:1) [35]. A direct blow to the medial clavicle is relatively uncommon. This force results in disruption of the posterior sternoclavicular ligament and produces a posterior dislocation. More frequently, an indirect force is transmitted through the shoulder to the sternoclavicular joint and results in either an anterior or a posterior dislocation. The type of dislocation depends on the position of the shoulder relative to the SCJ when the indirect force is applied using the costoclavicular ligament as a fulcrum [10, 26]. Anterior dislocations result if the shoulder is posterior to the SCJ and posterior dislocations occur if the shoulder is anterior to the SCJ [21, 35]. Posterior dislocations may damage the structures of the thoracic outlet and mediastinal space. About 30% of posterior dislocations result in compression of the great vessels, trachea, esophagus, or brachial plexus [4, 22].

The degree of sternoclavicular injury is classified according to Allman's classification. Type I describes a disruption of the sternoclavicular ligaments and capsule. Type II injuries cause a subluxation due to rupture of the sterno-

clavicular ligaments and capsule. Type III describes the rupture of all ligaments with a complete anterior or posterior dislocation [1, 4].

Clinical and radiologic evaluation of SCJ injuries

Sternoclavicular joint dislocations are frequently missed injuries and difficult to diagnose especially when concomitant injuries are present [31]. Clinically, anterior dislocations may demonstrate a prominent medial end of the clavicle, which can be accentuated by shoulder motion. Posterior dislocation may have a sulcus deformity at the sternal end [18].

Conventional radiographs such as an a–p chest X-ray, panoramic views or a clavicle series may be difficult to interpret because of the multiple overlapping structures in this area. On standard a–p radiographs, a difference in the craniocaudal positions of the medial clavicles greater than 50% suggests a dislocation (Fig. 1). Despite using specialized views described by Rockwood (serendipity) [35], Kattan [23] and Hobbs [20], the accurate identification of SCJ-dislocation is poor [20, 23, 35]. Adjunctive imaging is often necessary for diagnosis and surgical planning.

In trauma patients, a CT scan of the SCJ including coronal reconstructions with the patient supine is the most accurate imaging modality to evaluate joint alignment and articular surface congruity (Fig. 2a, b). Thin-section axial CT (≤ 3 mm cuts) and 3D reformation is the standard for diagnosis of SCJ dislocations (Fig. 3). MRI is a very effective modality for characterizing additional soft-tissue injuries, inclusive of ligamentous tears and cartilaginous injuries, but not always available in emergency cases [13, 26].



Fig. 1 Relative difference of craniocaudal positions of the medial clavicles suggesting dislocation of the left SCJ in the a.p. chest X-ray

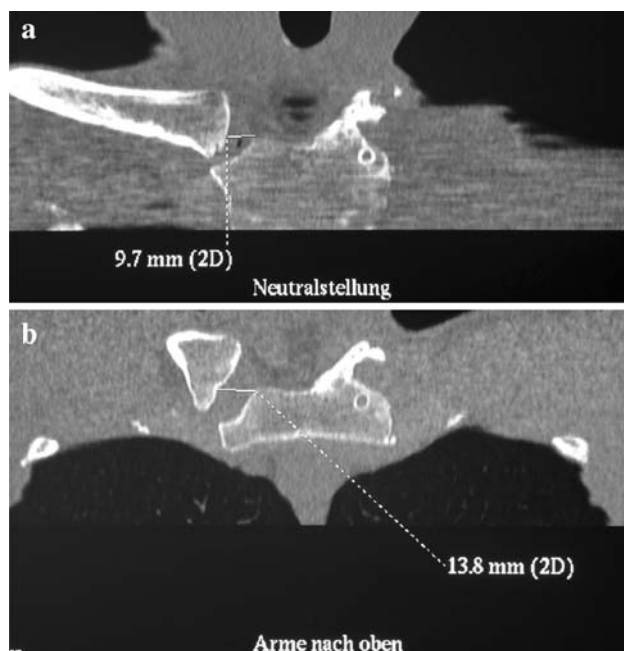


Fig. 2 **a** Coronal CT scan demonstrates and quantifies the amount of SCJ dislocation on the right side (neutral shoulder position). **b** Coronal CT scan demonstrates increasing SCJ instability during elevation of the right shoulder

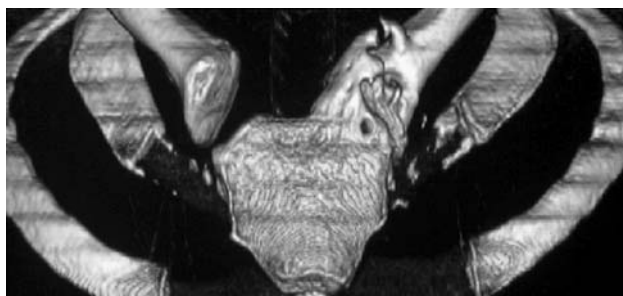


Fig. 3 3D reformation of the CT scan of both SCJ. Anterior SCJ dislocation is demonstrated on the right side. The left side demonstrates periarticular ossifications and persistent anterior instability after failed SCJ reconstruction in a county hospital. Notice the ap-drillhole in the manubrium

Treatment of SCJ injuries

Accurate classification of the dislocation may be useful to determine the appropriate treatment algorithm for SCJ injuries. A variety of treatment options has been described.

For an acute anterior SCJ dislocation, closed reduction within 48 h of the trauma and conservative treatment with immobilization in a sling or figure of 8 bandage for 4–6 weeks is recommended [4, 11, 29]. A lack of reduction or inability to maintain the reduction often occurs and is associated with recurrent instability of the sternal end of the clavicle and cosmetic deformity. Recurrent dislocations can cause chronic pain, periarticular calcification, and arthrosis.

In these cases, operative treatment is indicated [4, 12, 14, 35, 37].

Various operative procedures for reconstruction of the SCJ have been described. Burrows et al. [7] used the subclavius tendon to reconstruct the costoclavicular ligament and to stabilize the medial end of the clavicle.

Various authors have used a fascia lata graft to recreate the sternoclavicular and costoclavicular ligaments [2, 3, 6]. Furthermore, figure-of-eight reconstructions with free semitendinosus tendon or palmaris longus tendon graft have been described [14, 39]. Franck et al. [16] reported good results after surgical treatment of unstable SCJ with Balser plates.

A transosseous tension band technique using PDS cord is another reconstructive treatment option [17, 19, 21].

Further, resection arthroplasty of the SCJ is recommended for chronic SCJ instability. This treatment reduces symptoms associated with painful instability or significant joint degeneration [12, 34, 37]. When performing resection of the medial clavicle, preservation of the costoclavicular ligament is of primary concern; thus, iatrogenic superior displacement and instability of the remaining portion can be avoided [4, 5, 34].

Posterior dislocations usually require an immediate closed reduction because of their potential for mediastinal compression. In the supine position, with a bolster as a reduction aid between the scapulae, the patient's shoulder should be abducted to 90° and extended while applying traction. If unsuccessful, a sterile towel clip should be used to grasp the medial clavicle and apply anterior traction for reduction [4, 19]. If closed reduction fails, the aforementioned operative techniques are advocated for open reduction and SCJ stabilization [4, 12, 14, 34, 37].

For anterior SCJ dislocations, we attempt the nonoperative approach first. Patients who complained of painful instability after initial immobilization and subsequent functional training were treated surgically. Surgery included either resection arthroplasty or reconstruction using the transosseous tension band technique with PDS cord or wire cerclage. A follow-up study was initiated to evaluate the long-term outcome of operative treatment of anterior SCJ dislocations. The objective was to compare the outcome results of the resection group with the outcome of the reconstruction group.

Materials and methods

Study population

Between May 1977 and February 2004, 17 patients with anterior SCJ instability were treated operatively.

Six patients could not be included in our study because of lack of follow up. Two of these patients refused any further follow-up examination and four patients were not contactable because of missing actual personal data as telephone number or place of residence. Eleven patients (65%), seven male and four female were reexamined in our outpatient department between January and December 2004.

At time of injury, the mean age of patients was 29.2 (SD 13.5) years, ranging from 16 to 63 years. Because of delayed consultation in our outpatient department, diagnosis was not made immediately after trauma in ten patients (81.8%). The cause of the SCJ instability was a traffic accident in seven cases (1 pedestrian, 4 car drivers, 2 motorcyclists) and a sports injury in 3 cases. In one patient, heavy weight lifting was responsible for SCJ dislocation. One male patient also sustained an ipsilateral elbow dislocation and complex ulna fracture with median and ulnar nerve deficits. Open reduction and LCDC-plate osteosynthesis of the ulna and tension band wire fixation of the olecranon were performed.

Preoperatively, seven patients complained of painful motion in the shoulder girdle, two patients had SCJ instability, and two patients complained of pain and SCJ instability.

Operative treatment was performed at an average of 13 months (range 0–60 months) after diagnosis of the injury. Resection of the medial clavicle was performed in six patients. All of them had symptomatic anterior SCJ instability more than 2 months. In five patients, the SCJ was reconstructed and stabilized with transosseous tension band PDS or ligament reconstruction with additional wire cerclage. Reconstruction was performed within 2 weeks after diagnosis of anterior SCJ Instability (Table 1).

One patient of our study group had SCJ instability bilaterally. Although bilateral instability often indicates atraumatic SCJ instability [36], this patient sustained recurrent

sports trauma during heavy weight bearing. He had failed a previous reconstruction attempt at a county hospital. At our department, the left side was treated successfully by resection of the medial clavicle as revision treatment option.

Clinical follow up evaluation of the 11 patients was composed of a standardized questionnaire and physical examination. A scoring of the examination results was performed using the established shoulder scores ASES, DASH and power-, age- and gender adjusted Constant–Murley [9, 28, 33]. The mean follow-up period was 9.9 (range 1–27) years after treatment.

The long-term results in the group after resection of the medial clavicle (6 patients) were compared with the treatment results after SCJ reconstruction (5 patients). The resection group (cases 1–6) consisted of three female and three male patients. Two patients were injured on the right side and four patients sustained SCJ dislocations on the left side. The mean age was 31.7 (SD 15.7) years at injury, ranging from 16 to 52 years.

In the reconstruction group (cases 8–12), there were four male patients and one woman. Four patients had SCJ dislocations on the left and one dislocation was on the right side. The mean age in this group was 26.2 (SD 11.4; range 16–44) years. All patients in both groups were right handed. The patients of the resection group were treated at the average of 19.1 (SD 22.2; range 2–60) months after the injury or diagnosis. The patients in the reconstruction group had the operation within 2 weeks of the trauma. The mean follow-up time of 13 (SD 8.7) years in the reconstruction group was longer than in the resection group at 7.3 (SD 9.7) years.

Outcome assessment

During reexamination, the patients were asked to rate their pain and to determine whether they had any functional

Table 1 Data on patients with sternoclavicular dislocations and the results of treatment

n.	Sex	Age (years)	Diagnosis	Treatment	Follow up (years)	ASES	DASH	Constant	VAS (0–10)	Inst (0–10)	Power (lb)
1	f	56	Ant Inst	Resection	4	63.3	26.7	70	6	8	13.2
2	f	19	Ant Inst	Resection	3	76.7	2.5	98	4	10	15.5
3	f	78	Ant Inst	Resection	27	95	2.5	89	0	0	11
4	m	31	Ant Inst	Resection	5	20	57.5	56	8	7	6.6
5	m	29	Ant Inst	Resection	4	68.3	14.2	40	5	0	6.6
6	m	27	Ant Inst	Resection	1	96.7	0	99	0	0	19.9
7	m	42	Ant Inst	Wire	21	100	0	100	0	0	22.1
8	m	41	Ant Inst	Wire	22	100	0	100	0	0	22.1
9	m	45	Ant Inst	PDS	1	100	0	89	0	0	15.5
10	m	42	Ant Inst	PDS	11	63.3	26.7	62	0	1	17.7
11	f	26	Ant Inst	PDS	10	95	0	88	1	1	11

restriction of the shoulder girdle that resulted in limitation of daily activity, work or sports.

We assessed the function of eleven injured sternoclavicular joints using the American Shoulder and Elbow Surgeons Standardized Shoulder Assessment Form (ASES) [33], the Disability of the Arm, Shoulder and Hand Questionnaire (DASH) [28] and the Constant–Murley Score [9]. The methods used for clinical assessment of the shoulder address the following criteria: pain, activities of daily living (ADL), range of motion (ROM), strength, instability, and patient satisfaction. Numerical values, which are attributed to each criterion, form the basis of the aggregate scores (min 0–max 100 points).

The ASES and Constant–Murley Score include subjective information from the patient and objective information from the clinical examination. Scores range from 0 points (poor result) to the maximum of 100 points (best result). The DASH score represents only subjective information with good results tending to zero points [9, 28, 33].

The patients used the visual analog scale (VAS) to assess the pain intensity. Zero points indicate no pain and ten points maximum pain. For measurement of the isometric abduction strength of the injured shoulder girdle, we used the feather scale described by Moseley [27].

Statistical analysis

Microsoft Excel was used for data processing, and statistical analysis was performed using Prism Graph 3.0. A P value <0.05 was considered to be significant using the Mann–Whitney test as statistical measurement for small group numbers. The results of the ASES, DASH and Constant–Murley in both resection group and reconstruction group were compared using the Mann–Whitney test ($P < 0.05$).

Results

On follow-up, the mean age of our patients was 39.6 (SD 16.6) years, ranging from 19 to 78 years. All 11 patients reported right hand dominance. The overall results of the evaluated patients were good and the mean scores were calculated as follows: mean ASES 79.8 points (SD 24.9; range 20–100), mean DASH 11.8 points (SD 18.5; range 0–57.5) and mean Constant–Murley Score 81 percent (SD 20.7; range 40–100%).

Seven patients showed good results (Constant Score > 81 –100 percent), two patients had sufficient results (>61 –70 points), and two patients demonstrated poor results (<60 percent).

The shoulder scales we used offered a differential evaluation of multiple assessment domains: pain (VAS), activities

of daily living (ADL), range of motion (RoM), strength, instability (VAS) and patient's satisfaction.

The patients rated instability of their SCJ with a mean value of 2.5 (SD 3.9) points on visual analog scale (min 0–max 10). Pain was rated with a mean value of 2.2 (SD 2.99) points on the visual analog scale (min 0–max 10). Two patients (Table 1, cases 1 and 2) have complaint of more instability rather than pain from daily activities. One patient (Table 1, case 5) reported pain as the main symptom without instability. Four patients (Table 1, case 6–9) did not complain of pain or instability after operative treatment. Three patients described both pain and instability as restrictions (Table 1, cases 4, 10 and 11).

Isometric power of the shoulder girdle in 90° abduction was found to be an average of 14.7 pounds (range 6.6–22.1) using the feather scale. No significant weakness was found to be attributable to the SCJ injury.

On follow up the mean age of the resection group was 40 years (range 19–78 years), similar to the mean age of the reconstruction group at 39.2 years (range 26–45).

Comparing the follow-up results of both groups, the patients of the reconstruction group showed better scoring results for ASES, DASH and Constant–Murley (Figs. 4, 5). Three of five patients reached the maximum ASES score and complained of neither pain nor instability (Table 1, case 7–9).

Four of five patients were scored zero, which depicted the best result of the DASH score (Table 1, case 7–9 and 11).

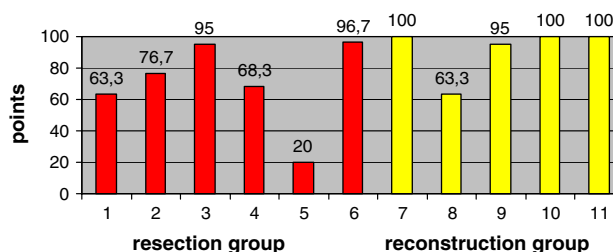


Fig. 4 ASES Scoring results of the resection arthroplasty group and the SCJ reconstruction group

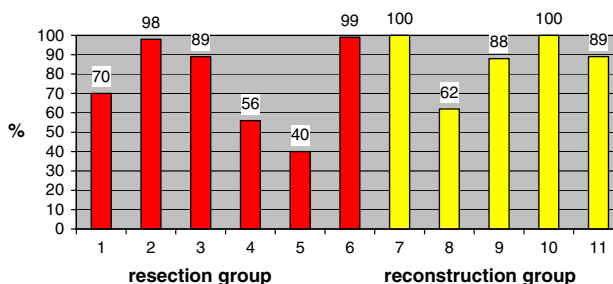


Fig. 5 Scoring results of the resection group and reconstruction group using Constant–Murley Score

Table 2 Statistical analysis of mean outcome data after SCJ resection or reconstruction

Shoulder score	Resection	Reconstruction	Mann–Whitney test (<i>P</i> value)
ASES (0–100 points)	70.00	91.66	0.1255 non significant (<i>P</i> < 0.05)
DASH (0–100 points)	17.23	5.340	0.1255 non significant (<i>P</i> < 0.05)
Constant–Murley (0–100%) (power-, age- and gender adjusted)	75.33	87.8	0.3290 non significant (<i>P</i> < 0.05)

The mean values of the ASES, DASH and Constant–Murley Scores were analyzed using the Mann–Whitney test ($P < 0.05$). The ASES, DASH and Constant–Murley Scores showed no significant difference between the results of the resection group and the reconstruction group when SCJ reconstruction was performed within 2 weeks of injury (Table 2).

One patient in the reconstruction group (Table 1, case 10) had sufficient results due to a concomitant ipsilateral elbow dislocation with a residual median and ulnar nerve injury (ASES 63.3 points; DASH 26.7 points; Constant–Murley 62%).

Two patients of the resection group (Table 1, cases 4 and 5) demonstrated poor results because of persistent instability of the residual clavicle.

The symptoms of pain and instability were analysed in the different treatment groups using the Mann–Whitney test. In the resection group, the mean pain on the visual analog scale was 3.8 (range 0–8) points and differed significantly ($P = 0.042$) from the pain in the reconstruction group 0.2 (range 0–1). The impairment due to instability did not differ significantly between the groups ($P = 0.4286$).

Discussion

Sternoclavicular joint injuries leading to anterior instability of the clavicle are rare. Individual surgical experience is very limited due to small numbers of cases receiving operative treatment.

Several studies have indicated that in anterior SCJ dislocations, the nonoperative approach is the treatment of choice [11, 35, 37, 38]. Nevertheless, anterior dislocations often redislocate or remain unstable during shoulder movement. In the case of an asymptomatic fixed anteriorly dislocation, conservative treatment should be continued [11, 35].

However, a significant number of patients with anterior dislocations complain of persistent or recurrent instability and marked functional impairment when performing over

head work or sports activity. Painful function of the shoulder girdle and SCJ instability are the main symptoms leading patients to ask for operative treatment.

De Jong et al. described the long-term follow-up results in ten patients with traumatic anterior SCJ dislocations [11]. The mean age of 36 years in their study population was comparable with the mean age of 29 years in our study group. The results of nonoperative treatment were evaluated after a mean follow-up period of 5 years; however, the outcome results after operative treatment of our study population were evaluated after a mean follow-up period of 9 years. The author described good results (10–12 points) in seven patients, fair results (7–9 points) in two patients and poor results (<6 points) in one patient according to the Eskola scoring [11].

Depending on the patient's daily activity level, a reconstructive procedure to stabilize the SCJ is recommended for acute instability. Many methods for stabilization of the SCJ have been described. An optimal, standardized operative procedure has not been established because of the small numbers of cases.

Techniques that attempt to reconstruct the costoclavicular and sternoclavicular ligamentous structures with the use of tendon grafts have shown good results [7, 14, 25]. Eskola et al. [14] reported outcome results of 12 patients who received operations for painful SCJ dislocations. The average age of their patient population was 29 years, which was equal to our study group. The mean follow-up time was 4.7 years. According to the Eskola scoring, only four patients showed good results (10–12 points). Three of these patients were treated with a tendon graft and one with fascial loops. Another four patients had fair results (7–9 points). All four patients treated with medial clavicular resection had poor results (<6 points). Eskola recommend not to resect the medial clavicle in chronic traumatic dislocations [14].

In contrast, in our study seven patients showed good results (Constant Score > 81–100 percent), two patients scored sufficient (>61–70 percent) and two patients demonstrated poor results (<60 percent) after operative treatment of SCJ instability.

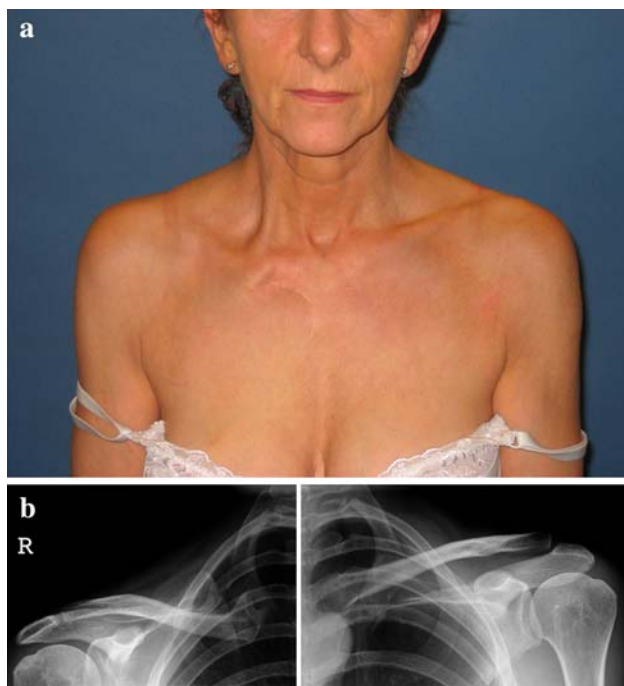


Fig. 6 **a** 52-year female patient with cephalad displacement of the right medial clavicle. This deformity is caused by the pull of the clavicular head of the sternocleidomastoid muscle following resection arthroplasty without maintenance of the costoclavicular ligament (VAS instability 8; VAS pain 6). **b** Follow up X-ray 4 years after resection of the medial end of the right clavicle. Cranial osteophytes at the medial clavicle indicate the traction of the sternocleidomastoid muscle

Other authors prefer PDS cord for SCJ fixation using a transosseous tension band technique. They describe good functional and cosmetic results [17, 21].

Spencer et al. [39] described the biomechanical importance of the posterior sternoclavicular joint capsule in preventing anterior and posterior translation of the SCJ. The anterior capsule acts as secondary stabilizer. Based on this information, reconstruction of the anterior and posterior joint capsules with figure-of-eight semitendinosus tendon graft was developed. They have published a cadaveric biomechanical study that demonstrates higher SCJ stiffness using this semitendinosus figure-of-eight tendon reconstruction in comparison to intramedullary tendon and subclavius tendon reconstructions [39]. Unfortunately, in cases with severe displacement, the soft tissue injury is so extensive that repair of the capsule and costoclavicular ligaments is hardly possible.

For old painful dislocations, failed SCJ reconstruction and degenerative problems, resection of the medial end of the clavicle is recommended [12, 34, 37]. In contrast, Eskola et al. [14] reported good results following chronic SCJ dislocations by stabilization with fascial loops or reconstruction with a tendon graft. The authors do not recommend resecting the sternal end of the clavicle due to poor

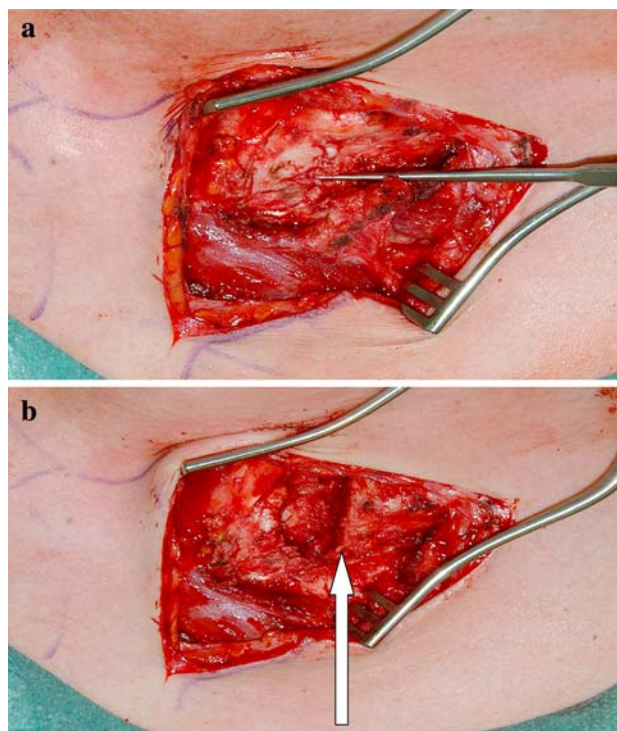


Fig. 7 **a** Intraoperative view of the SCJ. Following a skin incision parallel to the superior clavicular border and caudad onto the anterior surface of the manubrium, the periosteum is dissected carefully to preserve the periosteal tube and to protect the costoclavicular ligament. **b** Intraoperative view after oblique resection of the medial clavicle. The costoclavicular ligament has been left intact to maintain stability of the medial clavicle in relation to the first rib

results with pain and weakness of the upper extremity [14, 24].

On the other hand, Rockwood et al. [34] obtained satisfactory results after resection arthroplasty of the SCJ. Fifteen patients treated with resection of the medial clavicle were evaluated retrospectively and were divided into two groups. Eight patients who had had primary resection arthroplasty in which the costoclavicular ligament was left intact constituted group I. Group II was composed of seven patients who had had revision of a failed resection arthroplasty after reconstruction of the costoclavicular ligament. The comparison was performed at an average of 7.7 years postoperatively. All the eight patients in group I had excellent results. Three patients in group II had an excellent result, three had fair results and one a poor result.

The authors pointed out that preservation or reconstruction of the costoclavicular ligament is essential at the time of resection arthroplasty in order to avoid cephalad pull on the medial clavicle by the clavicular head of the sternocleidomastoid muscle (Fig. 6a, b).

The crucial point of the medial resection technique is the stabilization of the medial clavicular portion to the first rib (Fig. 7a, b) [7, 34].

In our study, good results were achieved after resection arthroplasty and reconstruction of the SCJ. Statistical analysis revealed that the long term results using ASES-, DASH- and Constant–Murley Score for evaluation did not significantly differ both after SCJ reconstruction or after resection arthroplasty (Mann–Whitney test $P < 0.05$). No differences were seen when comparing postoperative instability in the two groups. In our study, the reconstruction group complaint significantly less postoperative pain than the resection group. Equivalent postoperative results were obtained in the reconstruction group when the SCJ reconstruction was performed soon after injury.

Because of limited cases, differences in demographic data (mean age or sexual distribution) in the groups were not avoidable. Additionally, the mean follow-up period after reconstruction (13 years) was longer than after medial resection (6.9 years). However, we believe that the follow-up was sufficient to represent long-term results.

Our long-term follow-up study showed that good postoperative treatment results could be obtained after SCJ reconstruction or after resection arthroplasty. We recommend in acute instable cases reconstruction of the SCJ and in chronic, painful cases a medial resection of the clavicle.

A disadvantage of all studies continues to be the limited study populations. Because of the small numbers of cases, an optimal, standardized operative procedure is difficult to establish. Multicenter studies may help to increase the number of individuals in order to create homogenic patient groups for further outcome analysis.

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