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Surgical management of sternoclavicular joint septic arthritis

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ABSTRACT

Introduction: Infections of the sternoclavicular joint (SCJ) account for less than 1% of all joint infections. There are no standardized diagnostic and therapeutic algorithms defined in literature. This study intended to report the risk factors, the bacterial spectrum, the extent and localization and the clinical outcome of SCJ infections.
Patients and methods: We retrospectively reviewed the medical charts of 13 patients (8 men, five women, mean age 37.6 years) with SCJ infections between Januray 1st 2008 and October 30th 2015 for clinical parameters and radiological studies. All patients were interviewed during their follow-up along with clinical examination and assessing the Disabilities of the Arm, Shoulder and Hand questionnaire (DASH).
Results: Nine patients presented with local chest pain and swelling; in 4 patients, the prevalent symptom was pain without local signs of inflammation. Full blood count revealed a mean leukocytosis of 15×10^9 L and a mean CRP of 21.0 mg/dl. Approximately 61.5% reported known diabetes mellitus. 10 patients presented an involvement of surrounding structures. All patients received a preoperativ CT scan. Each patient was treated via SCJ resection without intraoperative complications. Primary wound closure was possible in all cases. The mean follow-up was 95 days. Wound culture revealed Staphylococcus aureus in all patients. Pathological examination affirmed acute osteomyelitis in 7 patients. Four patients required the intensive care of which 2 patients died from septic shock. Recurrent infection was encountered in 3 patients who underwent revision surgery. Mean DASH Score was 18.7.
Conclusion: CT should be routinely obtained to recognize the possible extends to the surrounding structures. SCJ resection can result in satisfactory clinical results and should be considered in cases of extended infections including the surrounding structures. Empiric antibiotic coverage should contain cephalosporin or extended-spectrum penicillin. Inappropriate or less-invasive surgical procedures may cause recurrencent infections, especially in cases of osteomyelitis.

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1. Introduction

Sternoclavicular joint infections (SCJ) are an uncommon condition accounting for less than 1% of all septic arthritis cases.[1] Etiology and presentation are variable and not well characterized, ranging from local indolent swelling to severe sepsis.[2,3] Various risk factors are described as associated with this infection, including male gender, the presence of indwelling central venous catheters, intravenous drug abuse, diminished immunity and chronic diseases such as chronic renal failure (CRF) and diabetes mellitus (DM).[4] Today, improvements in imaging technologies have led to a greater recognition of the extent of the infection, visualizing empyema,[5] retrosternal abscess formation,[6] osteomyelitis[7,25] or mediastinitis,[8] which frequently leads to surgical intervention. Recommendations for the management of these infections vary and include conservative management with i.v. antibiotics, local drainage or curettage and extend to a resection of the joint.[2,3] Due to the proximity of underlying major vascular structures and the lack of significant overlying tissue, surgical management can be demanding.[3] This study aimed to review our experience with the SCJ infections with special regards to the risk factors, diagnostic considerations, bacterial spectrum and treatment options.

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2. Patients and methods

We retrospectively reviewed all patients with SCJ infections during the period between January 2008 and October 2015. Medical files were then reviewed for of age, sex, preoperative symptoms, radiological findings, operative procedures, microbiology data, and clinical outcome. Wound cultures were obtained intraoperatively. A possible extension of the disease was evaluated by computed tomography, and the functional outcome was evaluated by the DASH score. The DASH Score has been proven to detect changes of disability over time after surgery in patients with upper-extremity musculoskeletal disorders.[9]

3. Diagnostic algorithm and surgical technique of SCJ resection

As a first step, patients with a clinical suspicion of an SCJ infection were examined with use of sonography, and a joint aspiration was initiated. The SCJ was aspirated and the synovial fluid examined by microscopy for the appearance of bacteria and crystals. Additionally, gram staining was used to achieve preliminary morphologic identification. Furthermore, we quantified the synovial fluid white cell count. Before starting empiric antibiotics (cephalosporin or extended-spectrum penicillin antibiotics), blood was cultured. Chest X-ray followed by computed tomography was performed in all patients. Considering hematogenous seeding, alternative foci of infection must be considered (e.g., dental status) and further diagnostic approaches may be required (e.g., transthoracic echocardiography). In cases of positive joint fluid analysis and/or suspicious clinical and radiological findings, SCJ resection was performed. For SCJ resection, we used a supraclavicular incision that extended from the medial third of the involved clavicle towards the suprasternal notch and then down the midline to the sternomanubrial junction. After exposure, the SCJ was then carefully separated from the surrounding structures. En-bloc resection into vital bone areas was done with an oscillating saw and a rongeur. Underlying structures were protected using Langenbeck`s retractors (Fig. 1). When preoperative CT scan revealed a retrosternal abscess formation, the manubrium was partially divided. The neighboring tissue after en-bloc resection of the SCJ was carefully debrided using a scalpel. Significant effort was taken to refrain from subclavian vessel injury leading to severe hemorrhage. Samples of the affected tissues were taken intraoperatively and cultivated to detect the underlying pathogen and to adapt the empiric antibiotics. In cases of an index patient (e.g., i.v. drug user, immigrant from eastern Europe) biopsies were tested for tuberculosis. Afterwards, the wound was closed over drains, avoiding tension. If a tension-free primary wound closure is not possible, secondary wound closure via VAC therapy or free functional muscle transfer should be considered after infection renovation.[10]

4. Results

We retrospectively reviewed 13 patients who underwent resection arthroplasty of the SCJ between January 1st 2008 and October 31st 2015 (Table 1). The 13 patients consisted of eight men and five women with a mean age of 37.6 years (range: 19–61 years) and a mean follow-up duration of 95 days (range 14–427 days). The most common risk factor was diabetes mellitus (eight cases), followed by ongoing immunosuppressive therapy in five cases. Two out of five were additionally intravenous drug abusers (both heroin). Eight patients had associated infection at other body sites. In two patients an underlying medical condition could not be identified. One of those patients had ipsilateral shoulder joint infiltrations due to omarthrosis. The preoperative shoulder joint aspiration did not show a pathological result. Five patients did not show any other infection focus. The clinical manifestation in nine patients was pain and swelling localized over the SCJ (Fig. 2). Four patients presented with an isolated swelling over the SCJ as the only complaint. Fever (temperature >38.0 °C) was present in three patients. Regarding laboratory findings at the time of admission, the mean CRP was 21.0 mg/dl (range: 3–50 mg/dl) with a mean serum leukocytosis of 15.0/nl (range: 3–26/nl). Initial plain chest radiographs were normally graded in ten cases. The radiographs
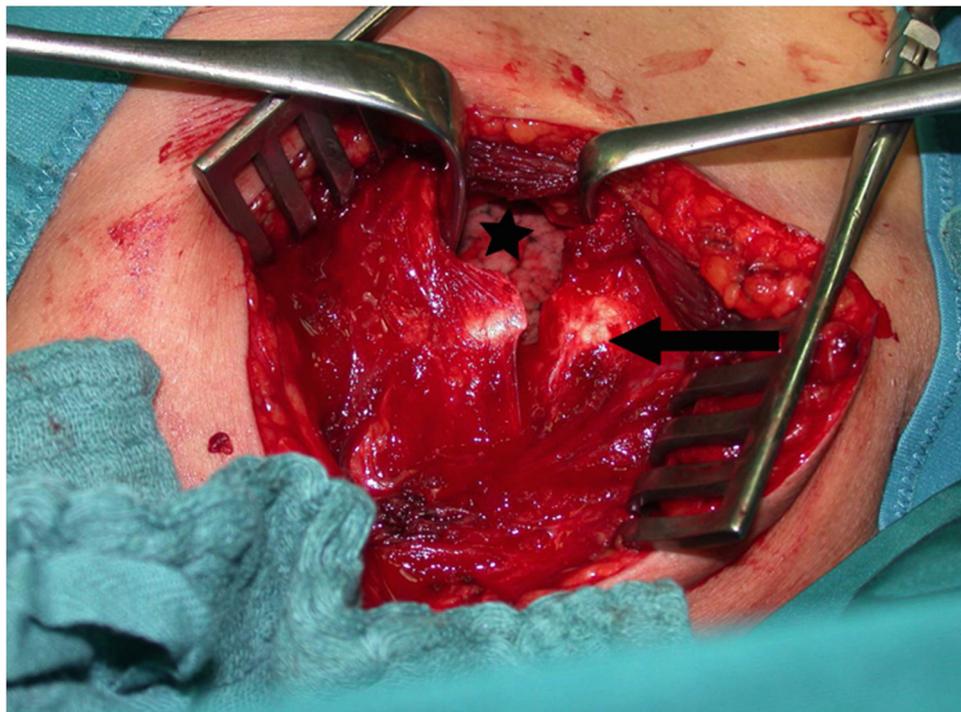

Fig. 1. Operativ findings after SCJ resections (arrow pointing at former SCJ region). Exposed apical lung (star).

Table 1
Patient population: diabetes mellitus (D.M), chronic renal failure (CRF), central venous catheter (CVC), Transurethal resection of the prostate (TURP).

Patient	Sex/Age	Risk factors	Other side of infection	Organism	Treatment	DASH-Score
1	W/74	DM, CRF, CVC	Local wound infection after forefoot amputation due to diabetic foot syndrome	Staph. aureus	SCJ resection	–
2	W/20	DM, CVC	Cervical spondylodiscitis	Staph. aureus	SCJ resection	19
3	W/63	DM, CRF, CVC	Thoracal spondylodiscitis	Enterobacter spp. / Staph. aureus	SCJ resection.	–
4	W/28	DM, Glucocorticoids	Local wound infection after transtibial amputation	Staph. aureus	SCJ resection	22
5	M/25	Intravenous drug addiction,	Upper ankle joint empyema	Staph. aureus	SCJ resection	17
6	M/19			Staph aureus	SCJ resection	18
7	M/45	Intravenous drug addiction, DM		Staph. aureus	SCJ resection	17
8	M/28	Glucocorticoids	Inflamed molar	Staph. aureus	SCJ resection	19
9	M/20			Staph. aureus	SCJ resection	17
10	M/61	_	MRSA in urine culture after TURP	MRSA	SCJ resection	18
11	M/20	DM, Glucocorticoids	Psoriasis arthritis	Staph. aureus	SCJ resection	17
12	M/23	DM	Ipsilateral shoulder joint infiltrations due to omarthrosis	Staph. aureus	SCJ resection	18
13	W/26	DM, Glucocorticoids	Cervical abscess of unknown etiology	Staph. aureus.	SCJ resection	24

**Fig. 2.** local swelling, erythema and tenderness around the left SCJ.

presented joint space widening in one patient and a soft tissue shadow widening in two patients. One of those patients showed radiological signs of an osteolysis at the medial end of the clavicle. In seven cases, additional SCJ anterior oblique views were performed due to clinical suspicion without radiological pathologies being found in the additional plain radiographs. CT scan was performed in all patients (Figs. 3 and 4) and revealed an abnormality in 10 patients (Table 2). SCJ resection was accomplished in all cases. In one case, a retrosternal abscess involved the first and second rib. Therefore, resection of the cartilaginous parts of the first and second rib was performed (Fig. 5). There were no intraoperative complications. Cultures of the intraoperative samples revealed *Staph. Aureus* in all cases. In one case, sensitivity testing revealed a methicillin-resistant *Staph. Aureus,* and accordingly postoperative antibiotic treatment was adapted (Vancomycin, i.v.). One patient had a mixed infection with *Enterobacter* and was treated with Tigecycline. The pathological examinations proved the diagnosis of SCJ infection in all cases. An acute osteomyelitis was revealed in seven cases. The mean hospital stay was 40.5 days (range: 10–114 days). One case presented a long hospital stay due to septic shock including 28 days of intensive care

followed by a prolonged weaning. Four patients required intensive care (mean stay on intensive care unit was 14 days; range: 4–28 days). The postoperative follow-up ranged between 14 and 427 days with a mean of 95 days. None of the patients showed limitations of shoulder movement. Under pain-relieving physiotherapy directly post-surgery, good agility was maintained (Fig. 1). The DASH score ranged between 17 and 24, with a mean of 18.7 points. Recurrent SCJ infection was encountered in three patients who were addressed as described below. A 45-year-old intravenous drug user (IDU) presented with a parasternal abscess two months after an initial retrosternal abscess drainage and SCJ resection. More extensive soft tissue debridement was carried out, and he received specific antibiotics recording to the culture and sensitivity. Despite continued antibiotics, the patient was readmitted again after six weeks with a parasternal abscess and fistula (Fig. 6). After secondary resection of the medial clavicula, final recovery could be established (last follow-up 427 days).

Another patient presented four months after SCJ resection, retrosternal abscess removal and bland primary wound healing with recurrence. The radiological finding revealed an abscess formation in the former SCJ cavity. Again, further resection of the

**Fig. 3.** Abcess formation SCJ and first sternocostal joint with retrosternal extension.
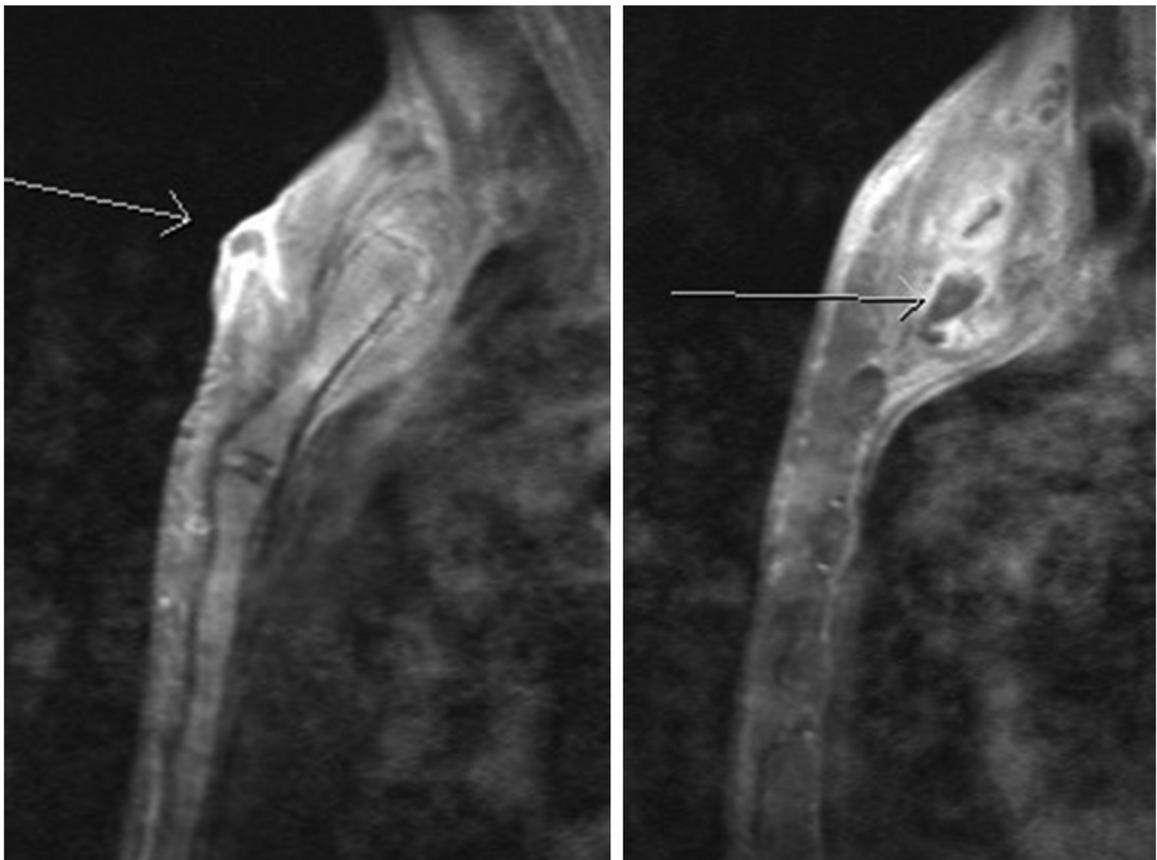
Fig. 4. Infiltration of M. pectoralis major and ipsilateral chest wall (arrow).

Table 2
Abscess localization.

Abscess localization	No. of patients
Retrosternal	4
Subclavicular	2
M. sternocleidomastoideus	2
M. pectoralis major/ ventral chest wall	1
Supraclavicular	1

medial clavicula was performed (pathological findings showed an ongoing osteomyelitis), and no recurrent infection occurred within a follow up of 173 days. One patient showed persistent wound secretion during the hospital stay, and revision surgery revealed involvement of the first sternocostal joint (Fig. 2). After resection, he was discharged.

Two out of four patients died from multiple organ failure following septic shock. These two cases presented with other infection sites (spondylodiscitis, inflamed distal phalanx due to diabetic foot syndrome). The first case, a 63-year-old female patient (adiposity, diabetes mellitus, COPD, heart failure, atrial fibrillation) presented initially with chronic lower back pain refractory to treatment without neurologic deficits (malaise, night sweats, CRP 4.9 mg/dl, leukocytosis 8.4/nl). Further diagnostics revealed spondylodiscitis and an SCJ empyema. With the absence of spinal cord/dura mater compression, spinal instability or abscess formation the spondylodiscitis was treated conservatively. Despite surgical treatment of the SCJ and empiric antibiotics, the patient died in septic shock multi-organ failure. In the second case, a 74-year-old patient initially presented with inflamed diabetic foot syndrome and systemic infection (fever 39.4 °C, CRP 17.8 mg/dl, leukocytosis 15.4/nl). Further predisposing factors were chronic
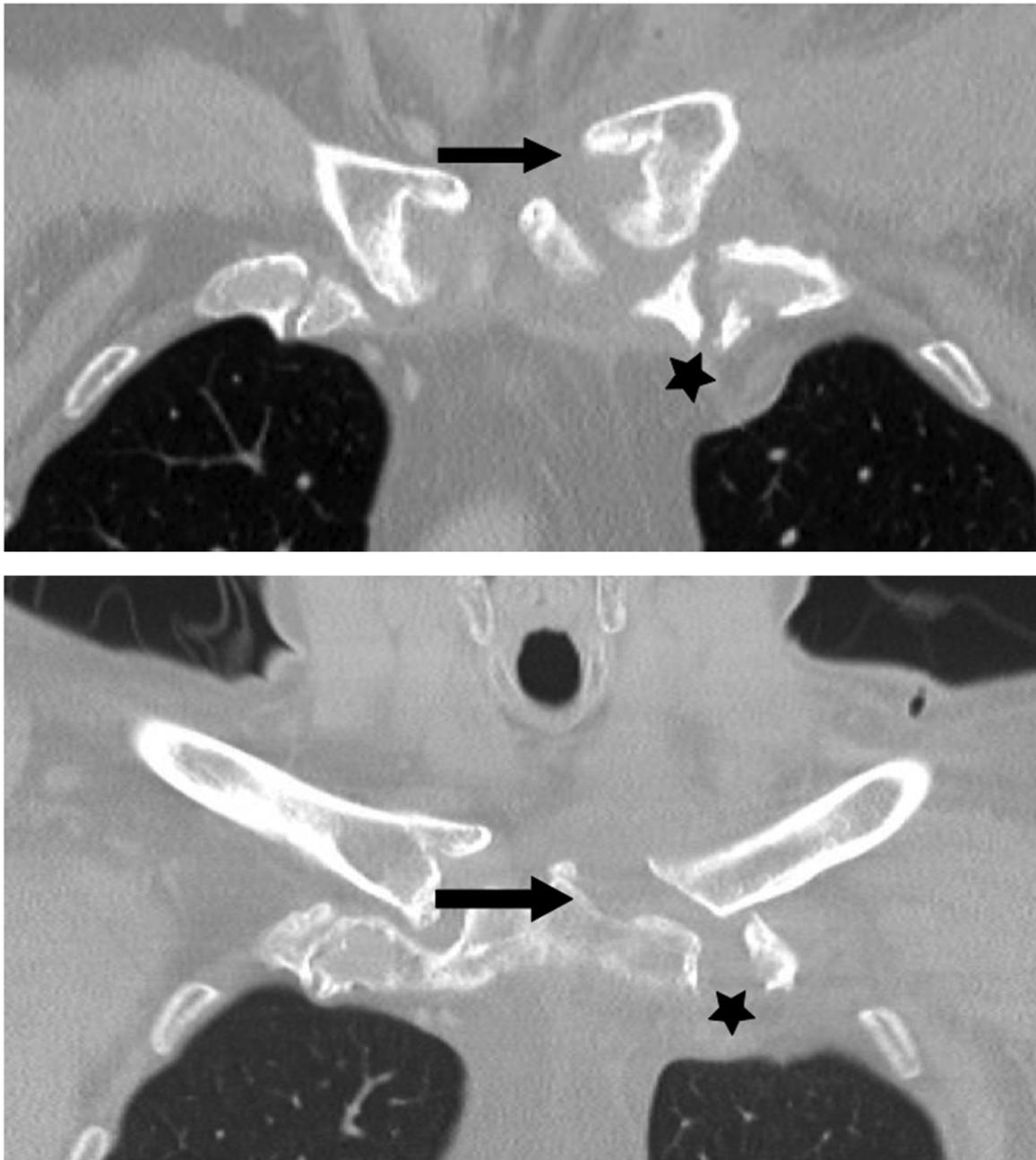
Fig. 5. Resection of the left SCJ (arrow) and the first costosternal joint (star).
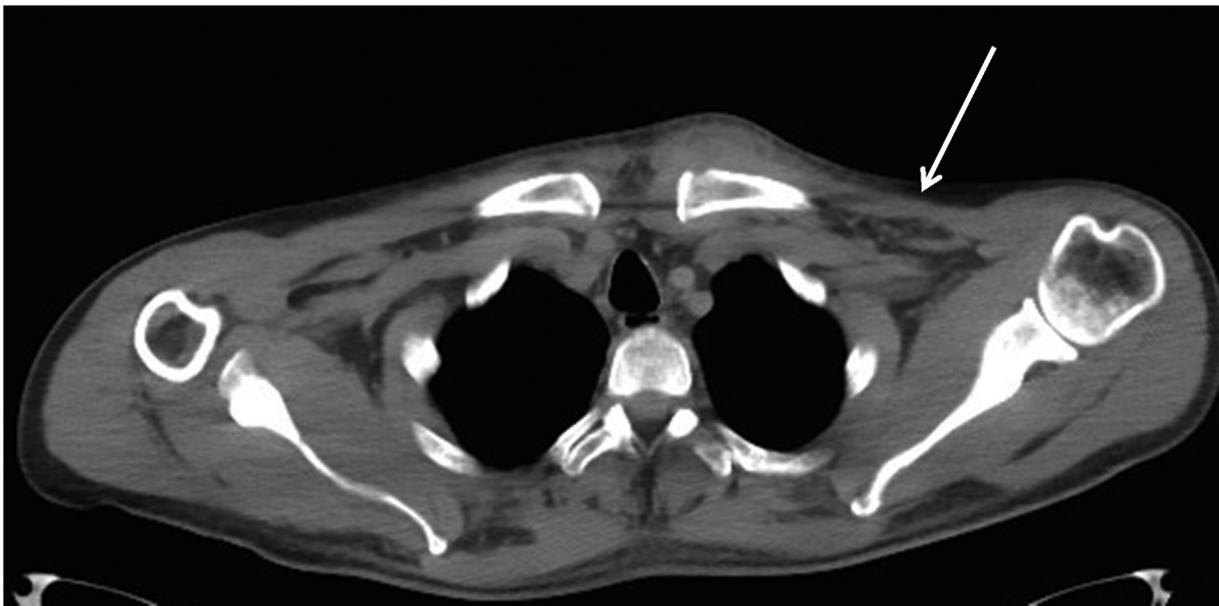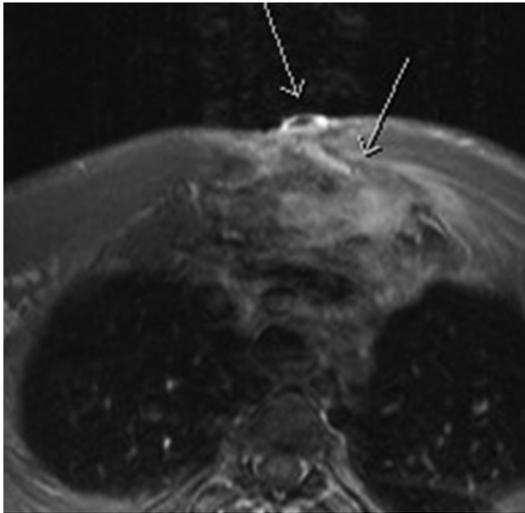
Fig. 6. MRI: Retrosternal abscess with fistula (arrows).

renal failure and a metabolic syndrome. Despite transmetatarsal forefoot amputation and SCJ resection, the patient died in multi-organ failure.

5. Discussion

Septic arthritis of the sternoclavicular joint is an uncommon entity that represents less than 1% of all bone and joint infections.[1,4] Therefore, clinicians often lack the awareness required to diagnose and treat this issue promptly. Several risk factors has been described to be affiliated with SCJ infection.[4,11–13] However, cases of spontaneously occurring SCJ infections especially in young healthy patients have also been reported.[14] SCJ infections commonly affects younger patients with an average age of approximately 45 years,[1,4,15] which resembles the results of our collective sample with a mean age of 37.6 years.

Anatomical reasons might explain why commonly younger people suffer from SCJ infections: classified as a true, saddle-type synovial joint, the SCJ`s intraarticular disc restrains the range of motion. According to structural similarities, it is regarded as functional amphiarthrosis[11] and can be related to further amphiarthroses such as the pubic symphysis or the sacroiliac joint.[4] Amphiarthrodial joint infections generally affect a much younger patient population. For instance, the average age of patients with pubic symphysitis is 48 years[14] and with sacroiliac septic arthritis is 22 years.[8,16]

Other common predisposing factors for SCJ infections include intravenous drug abuse, diabetes mellitus, rheumatoid arthritis, immunosuppressive disorders or medication and intraarticular injection.[14] In this study, the most common risk factor was diabetes mellitus in eight out of thirteen patients (61.5%), followed by glucocorticoid medication in four patients (30.8%). Intravenous drug abuse has been reported to be the main risk factor for SCJ infections in the United States.[17] Haddad et al. reported cases of SCJ infections without any risk factor, which can be confirmed by our experience.[14] Two patients in our cohort did not have any known risk factor. Nevertheless, bacterial septic arthritis of native joints is often secondary to hematogenous spreading, which makes the search for a potentially unknown focus mandatory.[19,20]

In many cases clinical presentation and laboratory findings may be unspecific and less alarming: four of our patients presented only with a swelling, without local signs of

inflammation such as redness or local warmness (30.8%). Furthermore, we observed a wide range and encountered patients with inconspicuous laboratory tests. Eventually, the strong joint capsule, which is reinforced by strong anterior and posterior sternoclavicular ligaments, could contribute to the delayed clinical presentation.[2,4,21] Severe SCJ infection results in prolongend hospital stay as shown in one of our cases (114 days). An early diagnosis is imperative for optimal treatment and helps to avoid prolonged hospitalization and sequelae of chronic infection.[14] Considering its applicability, sonography is the first step of diagnosis.[22] In case of the presence of swelling, the joint should be aspirated to dryness through a closed-needle approach and then gram-stained and cultured before starting empiric antibiotics to reduce the bacterial load.[14] In our experience, plain radiographs have a low accuracy in the evaluation of septic sternoclavicular joint arthritis. Burkhart et al. described 24 patients with SCJ infection in which only two patients presented a suspicious plain radiograph (i.e., joint space widening, bone destruction).[14] Due to their lack of sensitivity, plain radiographs are insufficient for imaging a pathological condition in this situation.[16,23] Therefore, in cases of clinical suspicion we additionally used CT scans in every case. Accordingly, we identified ten patients with an abscess formation (76.9%), which was an even higher incidence compared to Wohlgetan et al., who reported an abscess in 20% of the cases.[6] In addition, CT scans are fundamental for selecting the surgical strategy by identifying the involvement of sorrounding tissues.[4] Infection of the neighboring tissues has to be taken into acocount in order to find the optimal treatment for the patient. By the time a diagnosis is made, capsular structures may have ruptured, and/or the disease may have spread through the lymphatics.[5,6] In our study we found a high evidence of extra-articular involvement (76%), with potentially devastating sequelae due to the involvement of structures near the SCJ requiring an aggressive surgical management.[12,24] A conservative management alone may be suffice in early disease stages, knowing that a significant number of these patients will progress and require surgical intervention.[4] Walid et al. recommended a conservative therapy only in cases with minimal signs of inflammation and a radiographical confirmed limited disease.[4,15] Furthermore, unfavorable outcomes regarding recurrence or persistence of infection have been reported in conservatively treated patients, finally resulting in surgical management.[16,23] Abu Arab et al. described 14 patients who presented after failure of conservative treatment with antibiotic treatment (ranging from 3 to 4 weeks) and second, underwent surgical treatment.[15] Song et al. retrospectively evaluated less-invasive approaches (antibiotics, surgical drainage, and debridement) in six patients, reporting a failure rate of 83%.[3] The median duration of symptoms at presentation with an SCJ infection is approximately 14 days[4]; therefore, it is often a delayed diagnosis (approximately 3 days) making ongoing osteomyelitis and involvement of surrounding tissue more likely.[14,19] The infected bone or cartilage might be a potential source of reinfection.[25] Bayer et al. found an ongoing osteomyelitis at the medial aspect of the clavicle and Sternum in 8 patients.[26] Chun et al. confirmed the high incidence of osteomyelitis: ten out of ten patients had an ongoing osteomyleitis at the medial aspect oft he clavicle and additionally five patients had osteomyelitis at the sternum thus making curative surgery inevitable. [27] In defiance of our aggressive management, we still encountered a high recurrence rate (23.1%), which might have been caused by remaining infected bone after SCJ resection.[25] Further debridement of the clavicle was necessary in two cases, and one patient presented involvement of the first sternocostal joint as a possible source for recurrent infection. Choosing the resection margin of apparently non-infectious, vital bone is compulsory to achieve eradication of infection. Furthermore, our aggressive approach inevitably requires removal of the costoclavicular and posterior SC ligaments, which are particularly important for articular stability of the SCJ, more so than the bony structures.[14,27] Resulting joint instability is generally well tolerated, and the vast majority patients tend to have only little functional impairment.[28,29] During our follow up, no patient complained about reduced range of motion of the affected shoulder or impairment in daily living, which is also reflected by an average DASH score of 18.7. Kachala et al. observed a mean QuickDASH score of 19.3 ± 6.8 after resection; accordingly, a mild impairment is reported as a score of 25.[14] In behalf of the good clinical results and sufficient treatment of a potentially life-threatening infection, we recommend a thorough debridement plus SCJ resection followed by antibiotics (as soon as possible adapted to bacterial sensitivity).

Regardless of age and gender, *Staphylococcus aureus* is the most common bacterium, found in 44% of all septic arthritis cases[30] and is also reported to be the most common germ in SCJ arthritis,[4] which was confirmed in this study. Evidence on which to base choice or duration of antibiotic treatment for septic arthritis is limited.[14] A meta-analysis of antibiotic treatment for joint sepsis failed to demonstrate an advantage of any therapeutic regime over another for native joint infections.[14] Finally, antibiotic resistance in *Staphylococci* should also influence the choice of antibiotics that should cover streptococcus.[31] If the patient was transferred from a facility with a high prevalence of MRSA (Methicilin-resistant Staphylococcus aureus), or in cases if a appreciable high prevalence of MRSA, it must be considered, and Vancomycin would be our choice.[14] Furthermore, intravenous drug abuse and dialysis are valid risk factors and justify the use of Vancomycin.[4] The duration of antibiotics depends on the spread and severity of the infection. It ranges from 4 weeks in uncomplicated sternoclavicular septic arthritis up to 6 weeks in cases complicated by osteomyelitis or mediastinitis.[4] For patients who are coming from epidemic areas or are presenting with cold swollen joints,[29] tuberculosis should be considered. A multifocal involvement is rather atypical for tuberculosis,[14] and it most commonly involves the spine followed by the hip joint.[32] Nevertheless, there are case series decribing a SCJ infection in 1.3% of the patients with tuberculosis[33]; in cases of doubt, a combination of histopathological/microbiological tests and polymerase chain reaction (PCR) should be performed to exclude a tuberculosis.

This study has several limitations. First, this is a retrospective cohort study and the number of patients is relatively small. Due to the retrospective character of our study there might be factors we have missed in analyzing this entity. For instance, we had no valid information about the duration of symptoms at the time of presentation. Since SCJ infections are so rare a randomized trial or prospective cohort study would be time and cost prohibitive. We did not compare the outcome with patients who underwent a nonsurgical treatment. Furthermore, we did not perform any standardized tests assessing the stability of the former SCJ.

6. Conclusion

This patient series presents the considerable involvement of surrounding tissues around the SCJ, and therefore, a computed tomography and should be routinely obtained in the diagnosis of SCJ infections.Open-resection arthroplasty can result in satisfactory clinical results, and should especially be considered in cases of extended infections including the surrounding structures. Furthermore, empiric antibiotic coverage should include a *Staphylococcus aureus effective antibiotic*, such as cefazolin or piperacillin/tazobactam. Inappropriate or less invasive surgical procedures may cause recurrent infections especially in cases of osteomyelitis.

Conflict of interest

The authors declare that they have no conflict of interest.

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Ethical approval

This article does not contain any studies with human participants or animals performed by any of the authors.

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