Surgical Management of Sternoclavicular Joint Infections

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Background. **Infections of the sternoclavicular joint (SCJ) respond poorly to nonoperative management and typically require resection. We examined presenting characteristics and outcomes after surgical management of SCJ infections, reviewing a 20-year single-institution experience.**

Methods. **From January 1992 to December 2012, 40 patients (age, 57 ± 12 years; 70% male) underwent resection of an infected SCJ. Sternal infections after cardiac surgery were excluded. Clinical features, microbiology, recurrence, survival, and functional impairment were assessed. Infection was documented by the surgeon, and supported by tissue culture. Clinical presentation and treatment course were obtained by review of medical records. The functional assessment was determined by phone interviews using the validated QuickDASH outcome measure. Mortality data were gathered from the medical record.**

Results. **Pain was the presenting symptom in 93% of patients. Staphylococcal species were isolated in 73% of tissue specimens. Fifteen patients (37%) underwent primary closure and 25 patients (63%) underwent closure by secondary intention with application of negative-pressure wound therapy. There were four recurrences (10%), one after primary closure and three in the secondary intention group. No deaths occurred within 30 days of operation, and 5-year survival was 67%. Functional assessment using the QuickDASH outcome measure revealed minimal loss in upper extremity function after the procedure (preoperative score, 10 ± 3; postoperative score, 19 ± 6.8; n = 11). There was no difference in functional outcome comparing primary closure versus secondary intention (19 ± 4.4 versus 20 ± 8.2; $p = 0.64$).**

Conclusions. **Septic arthritis of the SCJ is routinely managed surgically at many centers. We report that primary closure with a muscle flap can achieve similar outcomes to secondary intention in selected patients. Furthermore, patients experienced minimal functional impairment at long-term follow-up.**

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The sternoclavicular joint (SCJ) is a synovial joint and the only articulation between the axial and upper appendicular skeleton. The joint includes the medial clavicle, superior manubrium, and first costal cartilage. A dense fibrous capsule contiguous with a fibrocartilaginous disc divides the joint into two synovial spaces and provides stability. Branches of the internal thoracic artery and suprascapular arteries are the primary blood supply to the joint. Like other synovial joints, the sternoclavicular joint is susceptible to arthritis, subluxation, and infection [1].

Septic arthritis of the SCJ is a rare condition with an unknown incidence. Causes include hematogenous spread of bacteria to the joint, direct extension from surrounding infection (eg, infected central venous catheter), and direct inoculation. Previously described risk factors include intravenous drug use, diabetes mellitus, existing primary infection at another site, trauma, and infected central venous catheter [2]. Current practice is based on expert opinion and small case series because of the rare presentation of this condition. Optimal treatment of SCJ infection remains surgical. Although needle aspiration or simple incision and drainage combined with intravenous antibiotics has been described [3], Song and colleagues [4] from the University of Pennsylvania observed an 83% failure rate in patients treated with simple incision and drainage in comparison with 100% cure in patients treated with formal joint resection and ipsilateral pectoralis flap advancement with primary closure in a nonrandomized population. Not surprisingly, as a result of surgeons' instinctive reluctance to close an infected wound space, joint resection with negative-pressure wound therapy (NPWT) is typically used in the current era [5]. We reviewed our single-institution experience with resected SCJ septic arthritis to examine the presenting characteristics of this disease, compared muscle flap coverage and primary closure versus NPWT, and assessed the long-term functional impact of the joint resection.

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Patients and Methods

Patients

We performed a retrospective review of all patients who underwent surgical management of SCJ infections at the Cleveland Clinic from 1992 to 2012. The study was approved by the institutional review board. Patients were identified using Current Procedural Terminology (CPT) surgical codes, surgeon operative logs, and a prospectively maintained institutional database. Patients who had previous median sternotomy, radiation necrosis, and cervical or thoracic inlet primary surgery were excluded from the study. Obesity was defined as a body mass index greater than 30 kg/m^2. All patients received a written questionnaire and a direct telephone interview to assess physical impairment after joint resection using QuickDASH [6, 7]. QuickDASH is a validated questionnaire designed to measure physical function and symptoms in patients with any or several musculoskeletal disorders of the upper limb. The questionnaire is scored from 0 to 100, with higher scores indicating greater disability. All patient data and follow-up were collected from the institutional electronic medical record, written questionnaire, or direct patient interview. Study data were managed using REDCap electronic data capture tools hosted at the Cleveland Clinic [8].

Surgical Techniques

We compared delayed versus primary wound closure in patients who underwent complete resection of their SCJ. First, a J or "hockey-stick" incision is made over the medial portion of the clavicle and extended along the midline. The sternal and clavicular heads of the sternocleidomastoid muscle are elevated off their insertion (Fig 1). The medial third of the clavicle, the hemimanubrium, and the medial end of the first rib are removed (Fig 2). Subclavicular dissection is performed close to the bone to avoid injury to the underlying subclavian vein. Necrotic and inflamed tissue must be aggressively debrided. Infection can extend well into the thoracic inlet and pleural space. Pulse lavage is frequently used for vigorous irrigation after debridement. The decision to perform primary closure or allow closure by secondary intention is made by the surgeon. Primary closure requires advancement of an ipsilateral pectoralis muscle flap providing tissue coverage for the debrided space. This can be performed in a limited fashion, mobilizing the upper third of the pectoralis major laterally to the delta-pectoral groove and the medial attachments to the sternum (approximately the third intercostal space) as previously described by Song and colleagues [4]. Alternatively, the entire pectoralis can be freed of its chest wall attachments maintaining its vascular pedicle [9]. The mobilized pectoralis is sutured in a tension-free manner to provide appropriate coverage of bony structures. Closed suction Blake drains are placed deep to the pectoralis. Drain removal is based on output and clinical assessment by the operating surgeon. Delayed closure is performed with either NPWT or packing with saline-soaked gauze. The resected joint is sent for pathologic review, and appropriate cultures are obtained to guide antibiotic therapy. Patients are placed in an arm sling to support the shoulder in the early postoperative period.

Results

Patient characteristics and clinical features are summarized in Table 1. Forty patients underwent resection for SCJ infection. The median age was 57 $\pm$ 12 years, comprising 28 male and 12 female patients. Obesity (body mass index $>$ 30 kg/m^2) was documented in 35% of patients and diabetes mellitus in 27.5%. Interestingly, chronic renal failure, indwelling catheters, and intravenous drug abuse each accounted for less than 15% of the total population. Pain was the predominant symptom reported in 93% of patients, followed closely by localized swelling (75%) and fever (45%). Only a third of patients (28%) had a draining sinus tract. Twenty-six patients (65%) had bacteremia documented before surgical intervention. Infection of the SCJ is believed to be a secondary infection resulting from the hematogenous spread of organisms into the joint. Analysis of concomitant infections presumed to be the source of the bacteremia revealed musculoskeletal infections and skin and soft tissue infection accounted for the majority of infections (40% and 25%, respectively). Although the preoperative course and evaluation varied among the cohort, computed tomography was almost uniformly performed in all patients to evaluate the SCJ (93% of patients). Computed tomography imaging identified increased joint fluid and abscess in 24 patients (60%). Magnetic resonance imaging was obtained in 9 patients (23%). Eight patients (20%) had an intervention before joint resection. These ranged from joint aspiration, incision, and drainage to incomplete joint debridement.

All patients underwent resection of the affected SCJ including the medial third of the clavicle, ipsilateral hemimanubrium, and ipsilateral proximal first rib. After resection 25 patients were managed with open wound care, predominantly with NPWT (19 patients; 79%). The remaining 15 patients were treated with primary closure after joint resection. The mean overall length of stay from surgery to discharge was 8.5 days. There were no in-hospital deaths, and 30-day mortality was zero. There were three reported wound complications, including wound dehiscence or seroma, and four recurrent infections requiring additional treatment. During subsequent follow-up we noted a total of 10 deaths, which yields a 5-year survival of 67% after resection.

Tissue culture of surgical specimens isolated an organism in 39 patients (96%). The microbiologic flora consisted of *Staphylococcus aureus* (23, 58%), methicillin-resistant *S aureus* (MRSA) (6, 15%), streptococcal spp (4, 10%), gram-negative species (3, 8%), and anaerobes (3, 8%). Antibiotic selection and duration were managed by the infectious disease consultant. Antibiotics were prescribed for an average of 5.5 weeks of intravenous antibiotics and 10.6 weeks of oral antibiotics postoperatively.

The clinical characteristics of patients undergoing delayed or primary closure have no significant differences (Table 2). Similar proportions of patients presenting with