

Received:
30 September 2015

Revised:
23 December 2015

Accepted:
30 December 2015

Cite this article as:

Kocutar T, Snoj Z, Salapura V. Complicated acute haematogenous osteomyelitis with fatal outcome following a closed clavicle fracture—a case report and literature review. *BJR Case Rep* 2016; 2: 20150389.

CASE REPORT

Complicated acute haematogenous osteomyelitis with fatal outcome following a closed clavicle fracture—a case report and literature review

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ABSTRACT

Among adults, post-traumatic osteomyelitis following a closed fracture is a rarely described entity in the literature, with the involvement of the clavicle bone being particularly uncommon. Early diagnosis and treatment of clavicular osteomyelitis is crucial to prevent serious consequences such as sepsis, mediastinitis and haemorrhage from the great vessels. A 54-year-old male patient presented to the emergency department complaining of fatigue and limited mobility after having fallen and hit his head and right shoulder 10 days previously. No major injury was found during the diagnostic procedure, and the patient was discharged. 2 weeks later, the patient returned with clinical signs of right upper arm cellulitis and probable sepsis. Diagnostic ultrasound imaging and MRI of the right upper arm, as well as re-examination of the X-ray image, confirmed acute complex osteomyelitis of the right clavicle following an overlooked clavicle fracture. Microbiological analysis confirmed clavicular osteomyelitis caused by *Escherichia coli* septicaemia. Despite prompt treatment with i.v. antibiotics and surgery, the patient's condition rapidly deteriorated and he passed away. Our case demonstrates the critical importance of early diagnosis and appropriate treatment of a closed fracture. Late diagnosis may lead to severe complications, such as complicated osteomyelitis and sepsis, and even a fatal outcome. Furthermore, a brief literature review is presented of previously reported acute osteomyelitis following a closed fracture, including evidence of affected bone and isolated pathogens. Although uncommon, osteomyelitis should be considered a possible cause of a deteriorating clinical condition in patients with a history of recent trauma.

INTRODUCTION

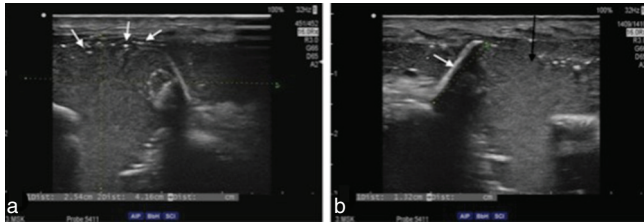
Osteomyelitis of the clavicle is an uncommon form of infection caused by haematogenous or contiguous spread, or trauma.^{1–3} This rare condition is difficult to diagnose. Pain and swelling of the medial end of the clavicle may be associated with osteoarthritis, infection or condensing osteitis, and it can be difficult to differentiate between these diagnoses from clinical and radiological perspectives.³ Despite modern surgical techniques and advances made in antimicrobial therapy, osteomyelitis remains a difficult and challenging problem.^{3–5}

Acute osteomyelitis caused by haematogenous spread predominantly affects children because their metaphyseal regions are highly vascular and susceptible to even minor trauma. Over half of the cases of acute haematogenous osteomyelitis in children occur in patients younger than 5 years of age.⁶ Haematogenous osteomyelitis among adults is most commonly seen in immunosuppressed patients and patients with underlying medical conditions (e.g. diabetes mellitus, cancer, chronic renal disease) or a

history of i.v. drug use.^{7–9} In adults, osteomyelitis typically involves the vertebrae, but can occur in the long bones, pelvis or clavicle.¹⁰ The common presentation of osteomyelitis includes the insidious onset of a dull pain, with or without signs of fever, tenderness, swelling and erythema. The formation of a soft tissue abscess, fluctuation or discharge appears late in the course of the disease.⁹

Post-traumatic osteomyelitis can occur in up to 26% of open fractures.¹¹ However, acute haematogenous osteomyelitis following a closed fracture is an uncommon complication in adults, with the involvement of the clavicle being exceptionally rare.^{1,12} Reports in the literature agree that aggressive and early treatment is strongly indicated.^{13–15} The aim of the treatment for clavicular osteomyelitis is to eliminate the infection in order to prevent serious consequences such as sepsis, mediastinitis and haemorrhage from the great vessels. Intravenous antibiotics should be instituted as soon as the diagnosis is suspected, and continued for 4–8 weeks. Wide local debridement represents the mainstay of the treatment.¹⁶ The presented case describes a

Figure 1. Ultrasonography of the supraclavicular region. (a) Subcutaneous hyperechoic, complex fluid collection extending above the right clavicle and between the clavicle fragments, with the presence of hyperechoic gas bubbles (white arrows). (b) A free fragment of the clavicle cortical bone (white arrow) surrounded with thick, hyperechoic fluid collection (black arrow).



unique example of acute osteomyelitis with rapid progression, serious complications and a fatal outcome after an overlooked closed fracture of the clavicle. Furthermore, a brief literature review is presented of previously reported papers of acute osteomyelitis following a closed fracture.

CASE REPORT

A 54-year-old male patient presented to the emergency department complaining of fatigue and increasingly limited mobility in his right arm. According to his records, the patient had fallen 10 days previously and hit his head and right shoulder. Right-sided subcutaneous facial haematoma and a contusion mark on the right shoulder were observed during physical examination. The examination showed a moderately limited range of motion in the right shoulder. A CT scan of the head and an X-ray of the cervical spine and right shoulder were performed. The CT scan of the head and the X-ray of the cervical spine showed no signs of injury, and the X-ray of the right shoulder was interpreted as normal. Besides a history of smoking and excessive drinking, the medical history was unremarkable. Laboratory examination showed a slightly elevated C-reactive protein inflammatory marker (22 mg l^{-1}), anaemia (red blood cell count = $3.02 \times 10^{12} \text{ l}^{-1}$, haemoglobin = 105 g l^{-1}), thrombocytopenia (platelet count = $46 \times 10^9 \text{ l}^{-1}$), low haematocrit (31%) and an alcohol blood concentration of 55 mmol l^{-1} . As no major injury was found, the patient was discharged. 2 weeks later, the patient returned to the emergency department complaining of fatigue, diffuse arthralgia and myalgia, with severe pain in his right shoulder. The skin on his right upper arm was swollen, reddened and painful to palpation, and his right axillary lymph nodes were enlarged. On examination, the patient had a pulse of $92 \text{ beats min}^{-1}$, blood pressure of $68/38 \text{ mmHg}$, oxygen saturation of 97% and a temperature of 36°C . Laboratory examination showed an elevated C-reactive protein of 129 mg l^{-1} , a white cell count of $11.6 \times 10^9 \text{ l}^{-1}$, red blood cell count of $2.09 \times 10^{12} \text{ l}^{-1}$, haemoglobin of 70 g l^{-1} , a haematocrit of 21% and a gamma glutamyl transferase of $1.36 \text{ } \mu\text{kat l}^{-1}$. The patient was hospitalized and diagnosed with right upper arm cellulitis and probable sepsis. An emergency ultrasound examination of the upper arm showed a collection of thick fluid with the presence of gas bubbles and a free fragment of the cortical bone (Figure 1). At this point, the shoulder X-ray image that was taken during the patient's first visit to the hospital was re-examined, and a clavicle fracture in the distal

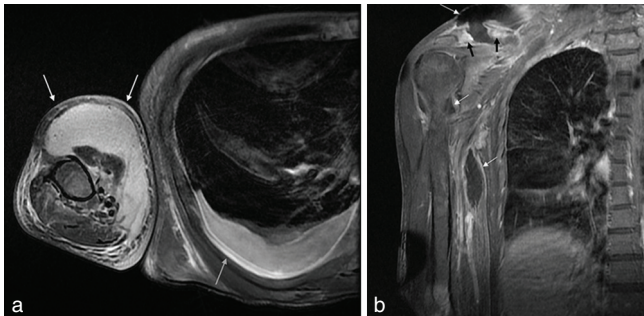
Figure 2. X-ray image of the right shoulder. A wide, lucent fracture line without dislocation between the fragments is seen at the distal third of the right clavicle (black arrow). The X-ray was taken during the patient's first visit to the emergency department and was misinterpreted as normal.



third of the clavicle was diagnosed (Figure 2). In order to assess the anatomical relations between the collection of fluid and its adjacent structures and to better evaluate the extent of bone involvement, we immediately performed an MRI on a Signa scanner 1.5 T (General Electric Medical Systems, Milwaukee, WI). The imaging protocol was performed using a short tau inversion-recovery sequence (coronal plane), a T_2 fast relaxation fast spin-echo (FSE) fat-saturated sequence (axial plane) and a T_1 FSE sequence (coronal plane) before i.v. application of the paramagnetic contrast media, and afterwards with a T_1 FSE fat-saturated sequence (coronal, axial plane). The MRI confirmed osteomyelitis of the clavicle and moderate right-sided pleural effusion (Figure 3a,b). Apart from these MRI findings, the X-ray of the lungs also showed radiological signs of possible infiltration of the right lower lobe.

Empirical therapy began with $2 \text{ g } 6 \text{ h}^{-1}$ of i.v. floxacillin and, after *Streptococcus pneumoniae* and *E. coli* grew in the blood cultures, $2 \text{ g } 6 \text{ h}^{-1}$ of i.v. cefotaxime was added to the therapy. No bacteria were isolated from the right pleural punctate and uroculture. A thorough physical examination revealed a deep $1 \times 2 \text{ cm}$ wound on the patient's left fourth toe, exposing the underlying tendon. The wound showed no signs of infection, but polybacterial flora grew on the smear taken from the wound, in which the presence of *E.coli* was identified. The patient was not a suitable candidate for immediate operation owing to abnormal haemostasis (prothrombin time = 68.9 s ; international normalized ratio = 2.45) and profound anaemia (treated with supportive therapy with three ampoules of phytonadione intramuscular and six units of concentrated

Figure 3. MRI of the right shoulder. (a) T_2 fast relaxation fast spin-echo fat-saturated sequence, axial images. Continuation of a large abscess distally encompassing the anterior compartment of the right arm. The fluid collection extended almost to the level of the elbow (white arrows). An additional finding was the moderate right pleural effusion (grey arrow). (b) T_1 fast spin-echo fat-saturated post-contrast images in the coronal plane. Clavicle fracture and destruction with a markedly diffuse, inflammatory post-contrast enhancement of the clavicle (black arrows). Peripheral ring enhancement of the supraclavicular and brachial abscess formation is evident (white arrows).



thrombocytes i.v.), until 2 days later, at which point surgical debridement and drainage were performed. A day prior to the surgery, there was a spontaneous discharge from the clavicle area of approximately 500 ml of pus. *E. coli* grew on a smear of the intraoperative right clavicular wound and a clavicle tissue sample.

Despite surgical treatment, the patient's condition deteriorated rapidly during the next 48 h with the development of acute respiratory distress syndrome and cardiac arrest with asystole. After successful cardiopulmonary resuscitation and the return of spontaneous circulation, systemic inflammatory response syndrome developed with multiple organ failure. The patient's condition deteriorated rapidly, and he passed away the following day.

DISCUSSION

The case presented demonstrates the critical importance of early diagnosis of acute osteomyelitis and the appropriate treatment of a closed fracture, as well as the importance of preventive treatment of skin and soft tissue wounds, which present a potential risk for local and systemic bacterial infection. This is especially important in patients with chronic diseases or otherwise immunocompromised patients, who are at greater risk of developing these complications.^{17,18} The patient in the case presented was diagnosed with advanced osteomyelitis, as a closed clavicle fracture had previously been overlooked, resulting in no standard therapy and follow-up. A chronic deep skin wound also had not been previously aetiologically diagnosed or treated, which could have presented an important preventative measure against later complications. Furthermore, this case demonstrates that osteomyelitis, although a very uncommon complication, should be considered a possible cause of a deteriorating clinical condition in patients with a history of recent trauma. All of these factors are crucial in contributing to an adequate treatment outcome.

With very few reported cases in the literature, haematogenous osteomyelitis following a closed bone fracture is an uncommon entity among adults. A MEDLINE search revealed that there have been 18 cases of osteomyelitis following a closed bone fracture in adults since 1976.^{19–33} Waldvogel et al³⁴ described the involvement of the clavicle in an infective process as being uncommon and usually secondary to the spread of infection from adjacent areas, and is often associated with predisposing factors such as head and neck surgery, radiation therapy, subclavian vein catheterization or immunosuppression in transplant patients. Concomitant with this statement, different authors have reported rare cases of clavicular osteomyelitis following central line placement,³⁵ Swan–Ganz catheterization,³⁶ trauma¹⁶ and as a complication after head and neck surgery.^{3,16} Our brief literature review revealed that *Staphylococcus aureus* appears to be the most commonly isolated pathogen in reported cases of haematogenous osteomyelitis following closed fractures.³⁷ Other commonly isolated pathogens are *Staphylococcus epidermidis*, *Pseudomonas aeruginosa*, *Serratia marcescens* and *E. coli*.³⁸

To our knowledge, only one case of acute haematogenous osteomyelitis following a closed fracture of the clavicle in an adult has been reported. The patient had Crohn's disease and previous sternotomies, and had developed *Salmonella* sternoclavicular osteomyelitis subsequent to *Salmonella* enteritidis sepsis.³³

The patient in our case suffered from a closed clavicle fracture without dislocation, which had been overlooked during his first visit to the emergency department (Figure 2). The upper arm of the patient was not immobilized when he was discharged from the hospital. Acute osteomyelitis of the right clavicle with severe complications subsequently developed. *S. pneumoniae* and *E. coli* grew in the blood cultures, and a clavicle tissue sample taken with a wound smear during surgery proved *E. coli* to be the cause of the haematogenous osteomyelitis. Isolation of bacteria from a bone biopsy sample, together with histologic findings of inflammation and osteonecrosis, is the reference standard for a diagnosis of osteomyelitis.³⁹

In terms of the underlying conditions that could have contributed to this devastating clinical course of haematogenous osteomyelitis in the patient, there are several factors that can be considered. One very possible factor is the immunocompetence of the patient, which may have been impaired owing to his long history of chronic alcoholism. *E. coli* has been described in the literature as a very commonly isolated Gram-negative bacilli in septicæmia.⁴⁰ *E. coli* and *S. pneumoniae* are more commonly isolated pathogens in cases of septicæmia in chronic alcoholism than in the general population.⁴¹ The most common foci of *E. coli* septicæmia are urinary tract infections; however, Gram-negative bacilli in acutely ill, debilitated patients, alcoholics; diabetics, and those with chronic bronchitis may also lead to *E. coli* pneumonia.^{40,42} Besides profound anaemia, concomitant *S. pneumoniae* septicæmia and right lower lobe pneumonia suggest the poor immune status of the patient in this study. In search of a probable primary focus of *E. coli* septicæmia, several different smears were taken, and *E. coli* was isolated from a deep skin wound on the patient's left fourth toe. All other tests were negative (pleural effusion sample, Sanford urine test). This finding underlines the importance of the preventive treatment of skin wounds in immunocompromised patients, especially in

specific body areas with a greater microbial burden.¹⁷ The prevention of infection demands gentle care of the wound in order to prevent additional trauma, maceration or alteration of normal microbial flora. If the wound becomes infected, it is vital that it is aetiologically diagnosed and specifically treated.¹⁸ For the patient in this case, the chronic wound on his foot had previously been untreated. Second, the patient's fracture had not been treated in the usual manner, that is, through immobilization with a figure-of-eight bandage or a broad arm sling,⁴³ as it was only diagnosed afterwards. It can also be argued that these factors worked in synergy or that other unidentified factors contributed to the rapid development of the disease.

A diagnosis of osteomyelitis in adults can be challenging and requires a high index of clinical suspicion.⁷ Imaging techniques play a key role in the early diagnosis and follow-up of trauma. In the event that osteomyelitis does develop, early diagnosis is critical, as prompt antibiotic therapy and surgical intervention may prevent necrosis of the bone. An inadequate or late diagnosis significantly diminishes the cure rate and increases the degree of complications and morbidity.⁴⁴ In our case, although osteomyelitis was diagnosed as soon as the patient presented to the hospital for the second time, the disease was already in an advanced state. Despite prompt treatment with antibiotics and surgery, the infection developed rapidly and aggressively, and the patient's condition deteriorated.

CONCLUSION

Early diagnosis of acute osteomyelitis and appropriate treatment of closed fractures are vital for a successful treatment outcome. Early diagnosis is crucial, since late diagnosis may lead to severe complications, such as complicated osteomyelitis and sepsis, and even a fatal outcome. This is especially important in patients

with chronic diseases or otherwise immunocompromised status. Although uncommon, osteomyelitis should be considered a possible cause of a deteriorating clinical condition in patients with a history of recent trauma.

LEARNING POINTS

1. Osteomyelitis of the clavicle is an uncommon form of infection caused by haematogenous or contiguous spread, or trauma.
2. Acute osteomyelitis caused by haematogenous spread predominantly affects children. Haematogenous osteomyelitis in adults is most often seen in patients with immunosuppressed status or with underlying medical conditions or a history of i.v. drug use.
3. Acute haematogenous osteomyelitis following a closed fracture is an uncommon complication in adults, with the involvement of the clavicle being especially rare.
4. Early diagnosis of osteomyelitis is critical, since prompt antibiotic therapy and surgical intervention may prevent necrosis of the bone.
5. Preventive treatment of skin and soft tissue wounds, as a potential focus of bacterial superinfection, which may lead to systemic infection with further complications, is especially important in immunocompromised patients.

CONSENT

We were unable to obtain a signed informed consent form from the patient or his next of kin; however, the National Medical Ethics Committee acknowledges that exhaustive attempts have been made to contact the patient's next of kin, to no avail, and that all information with imaging material has been sufficiently anonymized.

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