CASE REPORT

Rare presentation of Brodie's abscess in the acromion process and the value of the penumbra sign

Jelle Gorter,¹ Kyrill Rykov,¹ Pieter Ott,² Jos J A M van Raay¹

¹Department of Orthopaedic Surgery, Martini Ziekenhuis, Groningen, The Netherlands

²Department of Radiology, Martini Ziekenhuis, Groningen, The Netherlands

Correspondence to
Jelle Gorter,
jelle.gorter@gmail.com

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SUMMARY

A 17-year-old male patient presented with a swelling on his right shoulder 1 week after a fall. MRI revealed a superficial fluid collection of the acromion and trapezius muscle, with slight enhancement of the wall. The swelling burst open spontaneously after failed conservative therapy and was treated with surgical drainage and antibiotics. Tissue cultures showed a *Staphylococcus aureus*. 1 year later, he presented with local red discolouration and a recurrent painful swelling that fluctuated at palpation. Radiographs showed a lytic lesion of the acromion process. MRI showed a sinus in the lytic cavity and a penumbra sign, which helped to identify this extremely rare occurrence of Brodie's abscess in the acromion process that was breaking through to the subcutaneous fat. The abscess was treated successfully with surgical drainage and intravenous antibiotics. In retrospect, the first MRI showed a small cortical indentation, with slight oedema of the acromion process.

This case report describes the first case in the English literature of Brodie's abscess in the acromion process of a 17-year-old male patient. To the best of the authors' knowledge, this has only been reported once before in 1957 in an Italian journal.¹⁹ We discuss the use of modern imaging techniques that can help doctors to recognise this pathology, and the penumbra sign, which is a very helpful tool to differentiate between the many differential diagnoses.

CASE PRESENTATION

A 17-year-old healthy male patient visits the outpatient clinic with a swelling on his right shoulder that had emerged over the course of 2 days.

Approximately 1 year earlier, he presented at the outpatient clinic 1 week after a fall with a similar swelling on his right shoulder. Three days prior to his visit, he discovered a swelling on his shoulder. There was no visible haematoma or wound. Ultrasound showed a subcutaneous mass, measuring ~12×70 mm, some flow (mostly peripheral) and some small hard echoes. Since no fluid echogenicity was seen, a soft tissue tumour could not be ruled out. Subsequent MRI showed an inhomogeneous oval fluid collection, with slight enhancement of the wall, located between the subcutaneous fat and the fascia of the deltoid muscle (figure 1).

BACKGROUND

Brodie's abscess, first described in 1832 by Sir Benjamin Brodie,¹ is an intraosseous abscess and is considered a form of subacute osteomyelitis. Subacute osteomyelitis typically lacks the severity of symptoms seen in acute osteomyelitis and is characterised by a more insidious onset. Symptoms are various and non-specific, including mild localised pain (especially at night), slight functional impairment, localised tenderness, swelling and redness.^{2–4} Symptoms have often been present for weeks, or sometimes years, before a diagnosis is made.^{2 3 5}

A typical Brodie's abscess, according to the Roberts⁶ classification, is a type Ib subacute osteomyelitis: a cavity in the metaphyseal bone filled with pus and/or granulation tissue, surrounded by a layer of dense fibrous tissue and a sclerous zone. The location of the subacute osteomyelitis, symptoms and radiological presentation often mimics those of various benign and malignant tumours. Consequently, initial misdiagnosis is common.^{3 5 7 8}

Brodie's abscesses predominantly occur in young patients in their second or third decade.^{2 3 8 9} Men are affected 2–3 times more often.^{2 3 5 9} Brodie's abscesses most often occur in the tibia and distal femur,^{2–4 8–10} but other locations such as the talus,^{11 12} patella,¹³ proximal femur,^{3 14} cuboid bone,^{15 16} distal radius,¹⁷ fibula,⁹ clavicle,⁸ skull,² pelvis² and calcaneus have been described.¹⁸

Figure 1 Axial MRI of the right shoulder made at the time of the initial presentation. Axial T1 shows a dorsocranial fluid collection (star). Adjacent, in retrospect, there is some oedema in the acromion process, and a cortical indentation in the lateral acromion (arrow) in the location where the sinus was later discovered.

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A Morel-Lavallée lesion was suggested (because of the mentioned trauma). Initially, conservative treatment was set because the lesion was expected to resolve. However, the swelling burst open after 7 weeks and was then treated with incision and drainage. It was clinically suspected to be an infected Morel-Lavallée lesion. Abundant blood clots were seen during surgery but no pus or other fluid collection was seen. However, cultures of the removed tissue showed the presence of *Staphylococcus aureus*, sensitive to a wide range of antibiotics, including flucloxacillin. The patient was treated postoperatively with oral flucloxacillin (4×1 g daily for 10 days). The wound healed within 6 weeks, without any complications or apparent lasting symptoms for ~1 year.

A week before his most recent presentation, he started experiencing minor discomfort in his right shoulder. No trauma was reported. A slightly tender swelling appeared on top of his right shoulder 2 days prior to presentation. The patient did not have any pain in his shoulder; there were no symptoms of fever or illness, and nor was there pain in any of the other joints.

Physical examination showed a red-coloured swelling above the acromioclavicular joint, at the site of the former incision (figure 2). The swelling was slightly painful and fluctuated at palpation. Further examination of the shoulder showed no abnormalities.

INVESTIGATIONS

Laboratory testing revealed a moderately increased C reactive protein (CRP) level of 21 mmol/L, while erythrocyte sedimentation rate (ESR; 8 mm/hour) and leucocyte count ($8.6 \times 10^9/L$) were within normal range. Radiographs of the right shoulder revealed a lytic lesion in the acromion process (figure 3). A puncture of the swelling produced 8 cc purulent fluid, which was sent for culture. The patient was admitted to the hospital for intravenous antibiotic treatment (flucloxacillin 6×2 g intravenously daily, empirically chosen with the *S. aureus* in mind of the previous cultures). The swelling and pain increased the following day, despite antibiotics and the 8 cc drainage of the day before. The MRI that followed showed features consistent with Brodie's abscess in the acromion that was breaking through to

Figure 2 Photograph of the right shoulder taken at the time of the second presentation during surgical treatment. The anterior view shows the swelling on the shoulder (white arrow).

Figure 3 Radiograph of the right shoulder taken during the second presentation. The endorotated anterior-posterior radiograph shows an oval lucency with slight surrounding sclerosis in the acromion (arrow). Cranially from the acromioclavicular joint and clavicle, a soft tissue mass (no fat) is shown (star).

Figure 4 Axial MRI of the right shoulder made at the second presentation T1-weighted image at the level of the AC joint shows the abscess (star) in the acromion and small cloaca laterally (arrow). The abscess is outlined by a higher signal (isointense to muscle) curvilinear rim (called penumbra sign, representing granulation tissue). Low signal (oedema, and on this image posteriorly cortical bone) surrounding the abscess.

the deep subcutaneous fat, superficially of the acromion and trapezius muscle (figures 4 and 5). In retrospect, the first MRI showed a small cortical indentation, with slight oedema of the acromion process, which should have represented the sinus.

DIFFERENTIAL DIAGNOSIS

On initial presentation, the lesion on the shoulder could fit the pattern of a Morel-Lavallée lesion, which often presents as a (delayed) swelling after a trauma. Its radiological appearance

Figure 5 Coronal MRI of the right shoulder made at the time of the second presentation. (A) Coronal T2 Spectral Presaturation with Inversion Recovery sequence depicts an oval, slightly lobulated fluid collection in the acromion, with little surrounding oedema. A subtle lower signal rim demonstrates the penumbra (arrow). Cranially of the acromion and clavicle it shows a large collection in the subcutaneous fat (star). (B) Coronal T1 SPIR after intravenous gadolinium administration demonstrates both the collections with low-to-intermediate signal, surrounded by a high signal enhancing rim, representing Brodie's abscess with extension of the abscess superficially in the subcutaneous fat. SPIR, spectral presaturation with inversion recovery.

varies over time, but it can be mistaken for neoplasms.²⁰ Infections of untreated Morel-Lavallée lesions are known to occur, as are recidivist lesions and secondary infections after needle aspiration, so surgical treatment is often advised.^{21–23} The patient's quick recovery after the first surgical drainage and antibiotic treatment seemed to support the diagnosis of an (infected) Morel-Lavallée lesion or haematoma.

However, the lytic lesion in the acromion that was discovered at the second presentation did not fit the previous diagnosis. On plain radiographs, this lesion fitted the description of a typical Brodie's abscess: a lytic lesion with geographical destruction with well-defined edges and marginal sclerosis. Bone enlargement, periosteal reaction and cortical destruction are often absent and were indeed not seen on the radiograph (figure 3).⁸ Differential diagnoses of the radiographic features of a lytic lesion can include osteoid osteoma, non-ossifying fibroma, giant cell tumour, eosinophilic granuloma, chondroblastoma and fibrous dysplasia.⁸ MRI can be useful to further differentiate from the many tumour-like alternative diagnoses. Typically, an MRI of Brodie's abscess shows four 'zones' or 'rims'. The first zone represents the centre of the abscess and shows as a low-intensity signal on T1-weighted images (high intensity on T2-weighted images). The second zone consists of vascularised granulation tissue around the abscess cavity and shows as a relatively high-intensity signal (isointense to muscle) on T1-weighted images (also high intensity on T2-weighted images). The third zone consists of sclerous bone marrow and fibrotic tissue and shows as a low-intensity signal on T1-weighted images (and low intensity on T2-weighted images). The fourth zone consists of bone marrow oedema and shows as a low-intensity halo on T1-weighted imaging (low intermediate or high intensity on T2-weighted images).^{5 24–26} The presence of the second zone, the so-called 'penumbra sign' (figures 4 and 5), has a reported sensitivity of 73–75% and a specificity of 99% for subacute osteomyelitis.^{25–28} Nevertheless, sensitivity and specificity drop down to 27% and 96%, respectively, when differentiating any kind of musculoskeletal infection from a tumour.²⁹ The patient history was suggestive of an infectious problem, which was strongly supported by a positive penumbra sign. When the

diagnosis is unclear and conventional imaging techniques fail to offer a conclusive diagnosis, (hybrid) nuclear imaging techniques such as single-photon emission CT/CT, positron emission tomography/CT and technetium bone scans can be of value, especially for unconventional presentations or to identify multiple lesions.^{4 12 30}

Osteomyelitis of the acromion process is extremely rare, regardless of the type. Only two cases of acute osteomyelitis of the acromion process have been described in a case report from 1936.^{31 32} Furthermore, two cases of chronic osteomyelitis of the acromion caused by *Mycobacterium tuberculosis* have been reported.^{33 34} Tuberculous osteomyelitis also occasionally involves scapular lesions.^{33–36} The scapula, in general, is rarely affected by osteomyelitis, but scapular osteomyelitis has been reported as an extremely rare focus of chronic recurrent multifocal osteomyelitis.³⁷ Acute osteomyelitis of the scapula occurs slightly more often, but it is usually located in the scapular spine or inferior process.^{31 32 38–41}

Laboratory findings of Brodie's abscess are usually within normal limits, but sometimes CRP, ESR or leucocyte count are slightly elevated.^{2 5} In this case, only the CRP was slightly elevated, which made any type of acute osteomyelitis unlikely.

The pathogen that was isolated in this case is also typical; *S. aureus* is the most common pathogen found in Brodie's abscesses.^{2 3 9 10 42} However, no pathogen is found in 20–50% of the cases.^{2 5 9} In this case, the infection is thought to be a remnant of the *S. aureus* species that was cultured from the subcutaneous fluid collection a year before.

In retrospect, a small bone lesion was visible in the acromion process on one of the slides of the first MRI (figure 1). However, the presence of a fluid collection masked the presence of the lytic lesion of the acromion. This lesion was not noted at the time and was therefore not treated.

Figure 6 Photographs made during surgical treatment after the second presentation. (A) The dorsal view shows the incision over the posterior aspect of the acromion (arrow). Purulent fluid is draining from the incision (star). (B) The sinus was discovered dorsocranial on the acromion process (arrow). (C) The sinus was enlarged with a drill (arrow). (D) A gentamicin sponge was placed in the abscess cavity.

TREATMENT

Surgical debridement of the abscess was deemed necessary due to threatened skin, caused by persistent swelling. An incision over the posterior aspect of the acromion was made (figure 6A). The acromion process was reached after resection of the fascia of the trapezius muscle. The sinus was found centrally in the acromion and was enlarged with a drill (figure 6B, C). The abscess cavity was cleared and a gentamicin sponge was left inside (figure 6D). Again, cultures showed an *S. aureus* with an identical antibiogram. Intravenous flucloxacillin was continued for 2 weeks, followed by oral clindamycin (3×600 mg daily) for 4 weeks thereafter. Infectious parameters decreased and there were no complications in the postoperative phase.

OUTCOME AND FOLLOW-UP

Two months later, the patient showed clinical and radiographic improvement (figure 7). At 1-year follow-up, the patient had made a full recovery. Radiographs showed progressive osseous filling of the abscess cavity (figure 8).

DISCUSSION

This case report describes an extremely rare presentation of Brodie's abscess located in the acromion process. The occurrence of an isolated Brodie's abscess of the acromion has only been reported once in 1957 by Jannelli and Savoia¹⁹ in an Italian journal. The 36-year-old male patient in their case report presented with chronic pain in his shoulder with nightly exacerbations and slightly limited shoulder abduction. There was no fever or any visible swelling. The dorsal acromion was painful at palpation. Radiographs showed well-defined osteolysis of the acromion process with minor periosteal apposition.

Apart from the location, our case featured many classic characteristics of Brodie's abscess. The patient was an adolescent male patient with vague symptoms of discomfort and pain. Laboratory findings were negative, apart from a slightly raised CRP. The sudden onset of the subcutaneous swelling is noteworthy. The authors believe it to be the result of the abscess

Figure 7 Radiograph of the right shoulder taken 2 months postoperatively. The endorotated AP radiograph shows partial filling-in of the lucency peripherally and normalised soft tissue cranial of the AC joint area.

Figure 8 Radiograph of the right shoulder taken 1 year postoperatively. The exorotated AP radiograph shows a remaining slight cortical irregularity at the craniolateral side of the acromion.

breaking through the cortex of the acromion process and draining its contents to the subcutaneous fat. The mild discomfort prior to the development of the swelling could be well explained by an increased pressure in the abscess cavity that later spontaneously drained itself. Signs of high pressure in the abscess cavity have been previously mentioned by Miller *et al*,³ who noted that the pus often spurted from the bone when the abscess wall was pierced during surgery.

In retrospect, the first MRI showed subtle osseous abnormalities of the acromion process, fitting the location of the sinus (figure 1). This supports the diagnosis of a primary Brodie's abscess that had been latently present for some time, which became symptomatic after a trauma of the shoulder and might even have been the source of infection of the possibly coexisting Morel-Lavallée lesion. The abscess probably developed before epiphyseal closure and is most likely of haematogenous origin, since the first punctured fluid contained *S. aureus* and no wound or other port of entrance was discovered. Rasool⁴ emphasised the importance in distinguishing the true primary haematogenous form of subacute osteomyelitis, which occurs mainly in children, from types where previous (inadequate) antibiotic treatment might have played a role in the development of some sort of equilibrium between pathogen virulence and host immune response. Although the first presentation fits the description of a true primary haematogenous Brodie's abscess, the recent presentation can also be interpreted as the result of inadequate treatment or as a direct (re)infection caused by contamination during the previous surgery. Nevertheless, both types have the same clinical course. The often near-normal laboratory findings are perhaps a reflection of the 'equilibrium' between the relatively low virulence and slow-paced immune reaction.

The slow and relatively benign clinical course of subacute osteomyelitis poses difficulties in determining the appropriate treatment, conservatively with antibiotics or with surgical debridement combined with antibiotics. Several studies report satisfying results (up to 100% success rates), very low recurrence rates and few complications of surgical debridement.^{2 3 9 42} On the other hand, antibiotic treatment alone achieves similar excellent results.^{42–44} Many authors agree that surgical treatment is

indicated for aggressive lesions and for lesions indistinguishable from bone tumours with aggressive features and when a biopsy is necessary for diagnosis.^{42–44} In our case, despite the fact that no malignant alternative diagnoses seemed likely, surgical treatment was still chosen because of the extent of destruction of the acromion and the rapidly increasing swelling during antibiotic treatment. A gentamicin sponge was placed in the abscess cavity in order to provide optimal antibiotic treatment and minimise further acromion destruction. Gentamicin sponges have proven to be effective in the treatment of osteomyelitis.^{45 46}

Learning points

- Although Brodie's abscess usually presents in the distal femur or proximal tibia, it is known to occur sporadically in many other locations, such as—in this case—the acromion process.
- Brodie's abscess usually presents with non-specific symptoms, and its radiographic appearance can mimic various benign and malignant tumours.
- The penumbra sign on MRI is a very helpful tool to differentiate between the many possible diagnoses.
- Antibiotic treatment is adequate in the majority of the cases, but surgery can be helpful for aggressive lesions and lesions that are indistinguishable from bone tumours.

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