Infections of the Spine

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Contents

Abstract

Spondylodiscitis, tuberculosis and peri-operative infections are different sub-groups of the same problem that require specific attention. There are patient-related and case-specific risk factors for a spine infection that although well-documented and significant are unfortunately not generally recognized. In each pathological presentation of the disease the relevance of aetiology, epidemiology, diagnostic tools, as well as treatment modalities have to be well-established to clarify the differences between them. The costs of treatment and its failure have to be carefully evaluated. We must emphasise that a spinal infection is usually a treatable condition depending on the patient's immunological defences, the aggressiveness of the infecting agent, elapsed time to diagnosis, and the efficacy of the chosen treatment.

Keywords

Diagnosis, Imaging, Conservative treatment • Discitis/Spondylitis • Infections • Post-operative infection • Spine • Surgical indications • Surgical techniques • Tuberculosis

Introduction

Throughout history the spinal column has undergone changes, making the necessary adaptations to allow us to stand and walk, providing support

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to muscles or ligaments, to protect the neural structures and to facilitate daily living activities [1–3]. Pathological diseases such as spine infection can break this balance producing discomfort, pain and deformity. Also they can really endanger the patients either locally or systemically and thus become an important generalised disease. It is normally recognized that a haematogenous spine infection usually starts in the vertebral endplate area but it can spread from there to either the disc or the vertebral body [4, 5]. Several different infecting agents have been isolated including the most frequent staphylococcus aureus, mycobacterium tuberculosis and even rarely documented fungi. The literature indicates that old age can facilitate disease appearance, that there is no gender difference and also that, in spite of being a treatable condition, it might become a life-threatening situation especially if not properly treated [6, 7]. Diagnosis is often delayed and becomes a real challenge as the patient's symptoms and physical findings are often not severe. So early recognition becomes paramount in decreasing morbidity and mortality rates. For this purpose an exhaustive clinical examination complemented by an appropriate imaging evaluation is essential. As far as imaging is concerned PET scanning has 86 % accuracy and 100 % negative predictive value but MRI, on the other hand, has twice the sensitivity of a plain X-ray and can detect early changes, thus making both quite effective as diagnostic tools [4, 7–9]. The imaging potential of radio-labelled antimicrobial peptides, antibiotic peptides or chemotactic peptides have also been studied and they seem to have some advantage over the classic methods which might increase their role in the near future [10].

Discitis/Spondylodiscitis

Aetiology and Epidemiology

Discitis is an infection of the spine localized in the disc area but also simultaneously in bone and therefore the term "spondylodiscitis" is the most appropriate definition. Percutaneous spread or dissemination through the blood stream is usually the way pathogens reach the infection site. Staphylococcus aureus is often the infecting agent although other very rare organisms such as mucormycosis or even the *Lactococcus garvieae* might be involved [11, 12]. It represents around 2–7 % of all pyogenic osteomyelitis with an incidence reported from 1 per 100,000 to 1 per 250,000 a year [6] which makes it an uncommon condition and about 1 % of all bone infections [13]. It's a very rare in children less than 1 year old (Fig. 1) and although it peaks in childhood it seems to be more common in the elderly and in the lumbar spine rather than the cervical or the thoracic spine. It has been noted that 95 % of these infections involve the vertebral body, while only 5 % reach the posterior area of the spine [14, 15]. An epidural abscess is a possible complication in around 90 % of the cervical cases as well as 33.3 % of thoracic and 23.6 % of lumbar cases and we must bear in mind that it might also present as the primary lesion [5, 16].

Diagnosis

At an early stage of a spinal infection the inconclusiveness of either physical examination or symptoms can make diagnosis difficult (Fig. 2). Nevertheless clinical symptoms usually begin from 4 to 10 weeks before hospital admission and often the time between diagnosis and disease presentation can reach as much as 3 weeks or even 6 months. Therefore the spine surgeon should suspect a spinal infection whenever a patient complains of persistent pain specially if accompanied by systemic features like fever and unexplained weight loss as well as positive laboratory findings like C-reactive protein changes, increased erythrocyte sedimentation rate or raised white cell count [5, 7, 14]. Although many authors would consider these inflammatory parameters very useful others refer to their lack of sensitivity as well as specificity [8]. Therefore percutaneous biopsy remains an effective diagnostic tool in 60 % of all cases, whilst open biopsy is the chosen technique whenever the percutaneous route fails. It is also useful when

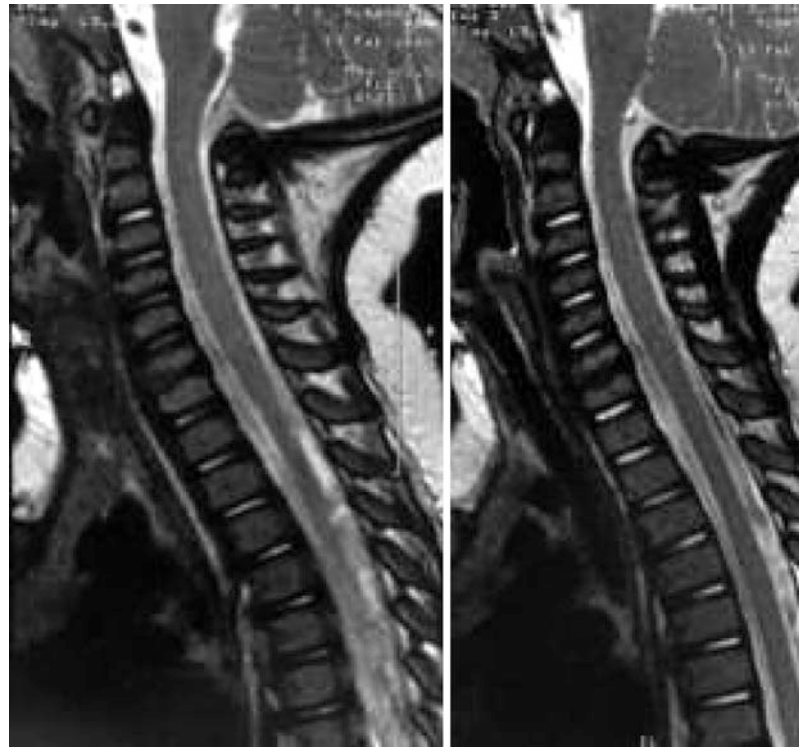

Fig. 1 MRI scan in C6-7 spondylodiscitis of 9 month-old child treated conservatively

the affected area is otherwise inaccessible without an open approach [14]. For this purpose it is important to note that sometimes histology can in fact produce a diagnosis even when no specific infective agent has been isolated [17] and that a percutaneous biopsy seems to be a more effective tool in diagnosing bacterial rather than fungal infections [18].

Imaging

Knowing that an exhaustive clinical observation as well as an appropriate imaging study can give the correct diagnosis even before microbial confirmation is obtained, the clinician should use a wide variety of laboratory and clinical tests complemented by different types of imaging to confirm the diagnosis. We know that the insignificant anatomical changes inherent to the early stages of the disease significantly reduces the relevance of X-rays, ultrasound, computerized tomography and even sometimes magnetic resonance imaging, but they all become more useful in advanced stages. Nuclear medicine evaluation, which at an early stage allows us not only the visualization of the inflammatory processes, but also the localization or the number of inflammatory foci, becomes much more relevant at that stage (Fig. 3). The radio-isotopic methods also help to detect either physiological or biochemical changes and thus facilitate the differential diagnosis from sterile inflammation [10]. However, they are not always readily available. Since they are expensive and considering that a plain X-ray can give some degree of useful information, although not at a very early stage, we really must define clearly what is the role of MRI or scintigraphy in detecting a spine infection?

MRI is especially important in un-operated cases but is currently of limited value to differentiate between oedema and active infection immediately after a surgical procedure or in the presence of metallic hardware. In fact this is also a problem, even when using nuclear medicine

Fig. 2 (**a**) Adolescent patient with an early stage spondylodiscitis T12-L1. No major changes in X-ray appearances. (**b**) MRI scan 3 months later showing extensive changes at the same level

techniques, where specificity also decreases immediately after a surgical approach. One might think that those problems could be overcome using labelled leukocyte scanning. Unfortunately it is useless to evaluate the spine due to high uptake of labelled leucocytes in hematopoietic active bone marrow [8].

PET-scanning, on the other hand, has excellent accuracy providing rapid results and some authors presently consider it the best option especially in difficult cases [8, 9]. There is not a clear option that applies to each and every case so we must realize that different types of image are in fact quite important but they have to be used according to the disease staging or its specific presentation otherwise misdiagnosis may occur.

Treatment

The correct treatment for spondylodiscitis remains a matter of debate. Nevertheless delayed or inappropriate treatment can be quite troublesome leading to widespread sepsis and subsequent organ failure with inherent higher morbidity and mortality. If we can achieve a correct assessment along with an early diagnosis we facilitate an adequate treatment for the disease which is crucial for its effective management. It has been said that spondylodiscitis might sometimes be a self-healing disease but even in such cases the possible remaining bone destruction can produce significant instability requiring further treatment [19]. In the absence of

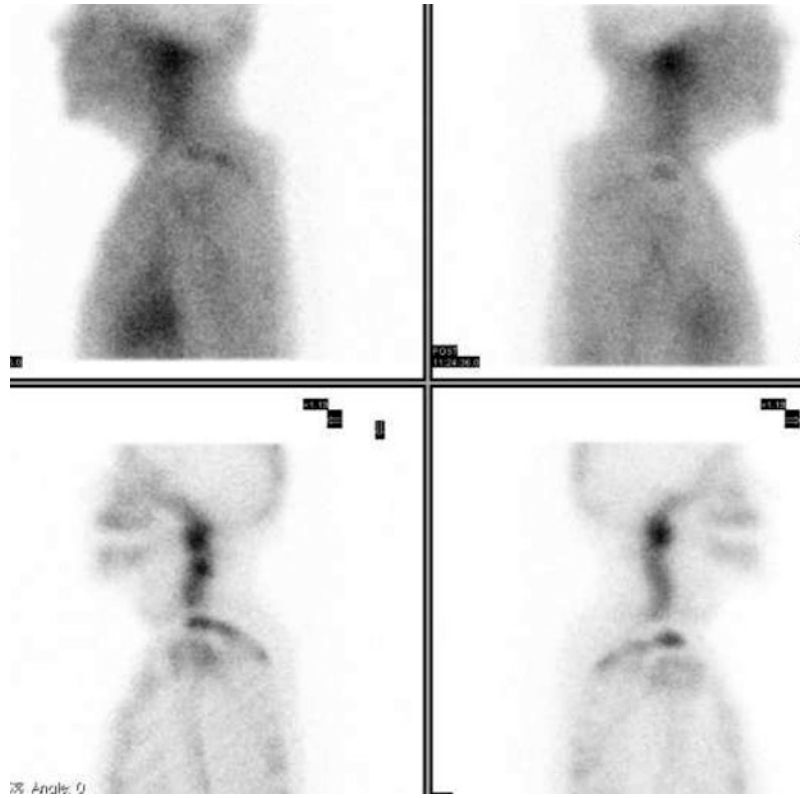

Fig. 3 Scintigram showing significant changes in the upper cervical spine of a patient with C2 infection and large abscess

neurological deficits or progressive symptoms spondylodiscitis will sometimes respond to non-surgical treatment, but otherwise surgery is the option. A wide number of treatment modalities for spinal infection have been suggested, from the non-surgical such as antibiotics and bracing to different types of surgery with anterior, posterior or combined approaches (Fig. 4). As we seldom find a corresponding clear indication for each one of them, at the end of the day the specific features of the cases will probably define treatment strategy. Even so, the option will often be aggressive treatment considering that a spinal infection might be the source of a generalised infection.

Conservative Treatment

When conservative treatment is indicated intravenous antibiotics given for at least 10 weeks, [14] sometimes in association with percutaneous drainage under imaging control, might still be the first option. Nevertheless 43–57 % of the conservatively-treated patients end up needing surgery, and we know that even with appropriate management 14 % may experience late recurrence [7]. On the other hand, we should note that difficult cases will usually require prolonged treatment for sometimes as long as 30 weeks [7] and conservative treatment can only remain an option if there's no neurologic deficits, no significant instability or deformity and no other symptoms. Otherwise, surgery is indicated [4, 5, 7, 16]. When compared with surgically-treated patients, conservatively-treated ones seem to have higher incidence of disabling back pain and worse functional and radiological outcomes. Surgery can in fact be the best option and some would consider that an anterior debridement is a better solution [15] whilst others would claim that a simple direct discectomy or even a transpedicular discectomy are the best techniques. However surgery is definitely the choice whenever we need to reduce deformity or stabilize the spine [20] and then we often also need additional instrumentation which has long been considered controversial in active spine infections.

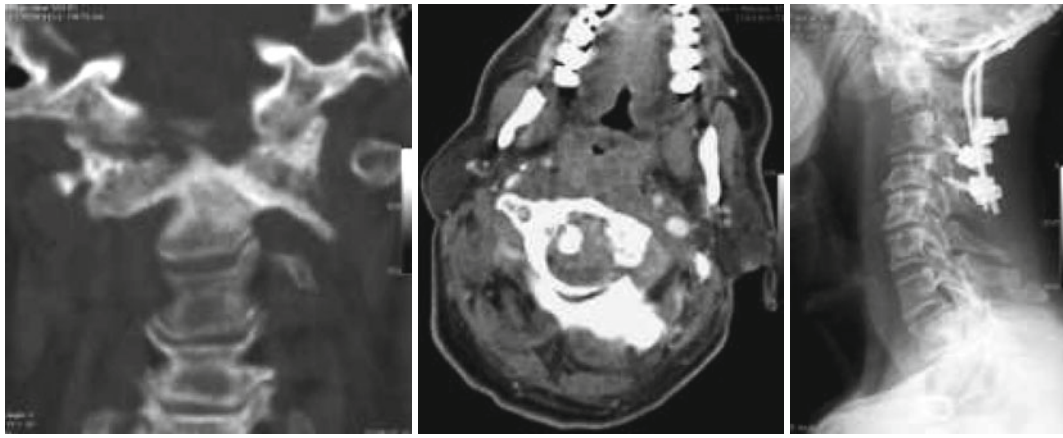

Fig. 4 C2 infection and significant abscess treated with transoral dens removal and occipito-cervical instrumented fusion

Not using instrumentation is not the absolute solution as poor sagittal correction has been reported after non-instrumented fusions [15]. This fact leads many surgeons to clearly recommend instrumented fusion, but the exact role of instruments as well as graft material remains also a matter of debate [4, 19, 21]. Some [5, 13] would support the efficacy of aggressive debridement, anterior bone grafting and posterior stabilization (Fig. 5). If there is not significant vertebral body destruction others would suggest that an anterior titanium mesh cage filled with bone graft and combined with anterior plating is an acceptable solution [15, 20, 22]. In low risk patients there are also favourable reports on the use of PEEK cages without additional instrumentation to treat pyogenic discitis in the cervical spine [22, 23]. But of course the state of the art as far as surgery is concerned is to debride the infected area and stabilize the spine in the best way but always bearing in mind that no matter what operation you perform you will have to employ intravenous antibiotics for no less than 6 weeks [16].

Tuberculosis

Tuberculosis seems to be increasing everywhere and not only in developing countries where nevertheless the problem is definitely more significant. There are approximately 3.8 million new cases reported each year around the world and probably a very significant number not reported or mis-diagnosed. The so called "re-appearance" of the disease might somehow be related not only to the increased immunocompromised patients but also to the multiple drug-resistant strains and of course different socio-economic factors [24].

Aetiology and Epidemiology

When we consider tuberculosis the Koch bacilli are the infecting agents and the infection can be localized in different body areas as is well-recognized. Coming from either the bloodstream or the lymphatic supply the bacilli may reach the anterior portion of the vertebral body and then, with a high probability, develop spinal tuberculosis. Nevertheless, it will only happen in less than 1 % of all skeletally-infected patients. Especially in uncontrolled patients neurological deficits and deformities such as localized kyphosis are sometimes observed and need to be aggressively addressed. We must realize that even when using histology or culture it is sometimes difficult to differentiate between tuberculosis and a pyogenic infection, in fact it can only be achieved in around 62.2 % of cases [24].

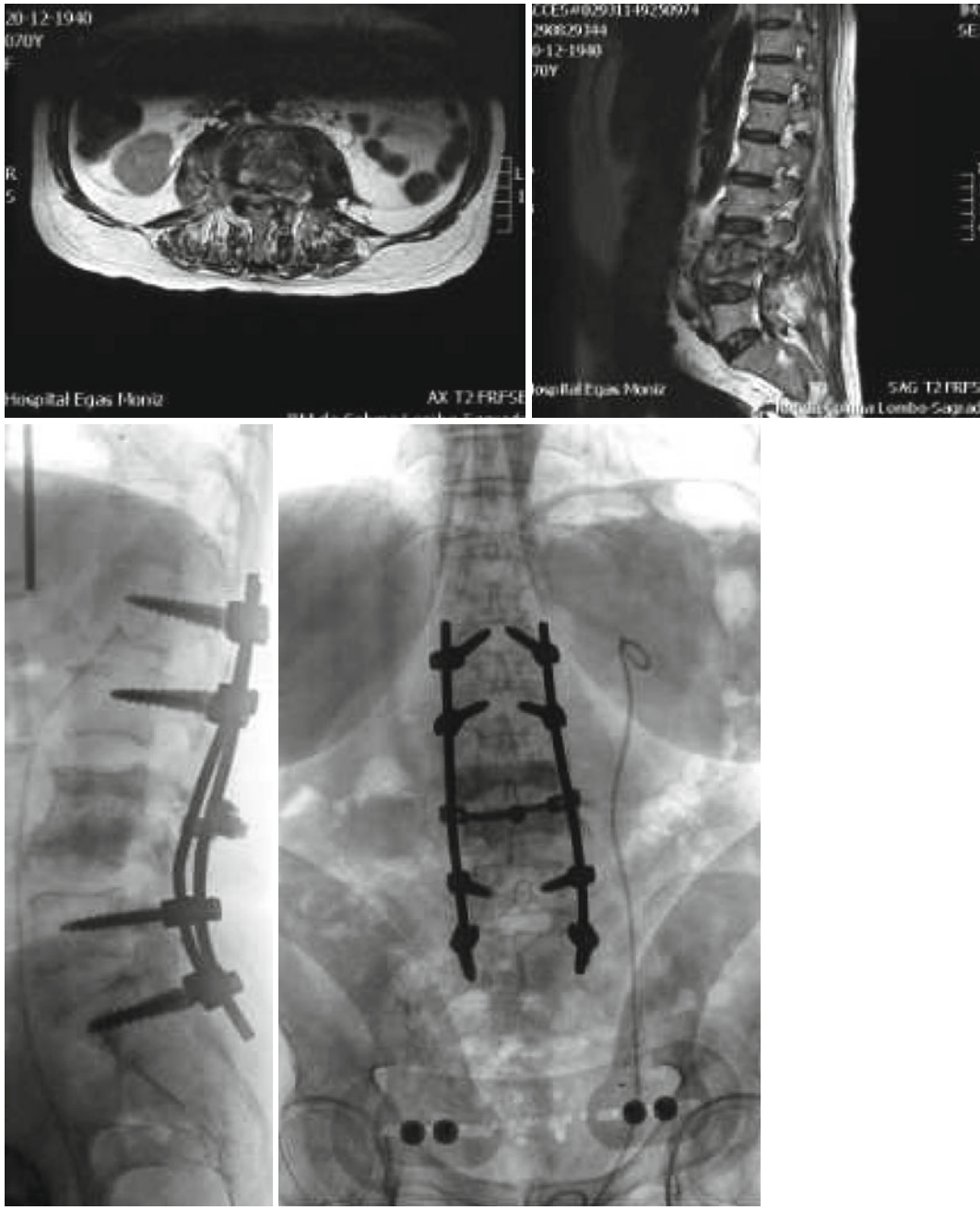

Fig. 5 Lumbar infection and vertebral destruction treated with anterior decompression and fusion associated with long posterior instrumentation

Diagnosis

In spite of only being diagnostic in around 2/3 of the cases, histology and culture are still indispensible as diagnosis is often not an easy task. The delay in diagnosis can become a relevant factor considering shortening of the elapsed time between symptoms and treatment. The physician must carefully identify all the patient's symptoms related to the clinical picture and of course even more so if the

patient already has the disease diagnosed elsewhere. Some authors will claim that even in the presence of a low-virulence pyogenic infection one must suspect co-existent tuberculosis if the disease is not responding as expected to the prescribed normal antibiotics, or if the patient is immunocompromised or if a psoas calcification is identified [24].

Treatment

Treatment in spinal tuberculosis is chosen according to the patient's symptoms as well as disease involvement and all this after careful evaluation of any neurological deficits, existent deformity or instability, addressing each one of these problems by itself in an overall perspective, looking for total disease control. At the present time we can usually achieve an early diagnosis and this can make a difference as far as treatment effectiveness is concerned. The new drugs and more effective types of instrumentation allow us also to achieve better results from the prescribed treatments. The assessment of the levels involved, the existence and location of an abscess or bone destruction must be made in selecting adequate treatment. Minor cases can be controlled conservatively with anti-tuberculosis drugs, and this should probably be always a first choice, but more severe cases will definitely need additional surgery and the infection site must of course be thoroughly cleared.

Indications for Surgery

As is well-recognized, surgery is indicated whenever there are significant deformity, major instability, important neurological deficits, large abscesses or failure of conservative treatment leading to either progression of symptoms and signs, or increased bone involvement. There is no single generalized technique for all patients. A wide anterior debridement and fusion, a front and back fusion, either in one or in two procedures and a posterior-alone fusion have all been suggested and all aim to achieve surgical treatment goals. These are; controlling the disease by decompression, exhaustive debridement, realignment of the spine, stabilization and fusion. It has been mentioned that a simple posterior decompression and instrumented fusion can effectively solve an early stage, small bone destruction and mild kyphosis case [25]. Nevertheless these results seem to be comparable with those obtained after an anterior approach and, even if both approaches can significantly address the kyphosis, both will also allow some degrees of correction loss that has to be taken into consideration. Bezer et al. [26] also demonstrated that it was possible to do an anterior decompression and fusion through a posterior approach preventing lumbar kyphosis and maintaining sagittal balance which is quite important considering this is a less aggressive technique. Other authors [27], specifically at L5-S1, also reported good results doing a TLIF (Transforaminac Lumbar Interboy Fusion) to handle patients with failure of conservative treatment, localized kyphosis, neural compression and limited destruction of the disc as well as adjacent vertebral bodies. So in general it seems that surgery must be chosen in an individual manner depending on disease specificity, patient characteristics and the surgeon's ability to perform each technique. As with other pathologies our spinal tuberculosis patients should be treated with the least aggressive, most effective and long-lasting technique but this, unfortunately, cannot be systematically applied all the time.

Post-Operative Infection

Post-operative infections are sometimes very problematic and troublesome complications of spine surgery. They can be diagnosed immediately after surgery but sometimes even several years later (Fig. 6). We must always be aware of this possibility and take all measures to avoid it by meticulous techniques. We also have to realize that the use of a simple dilute betadine solution can moderately reduce the risk of infection. Meanwhile pursuing an understanding of what can facilitate infection, why some patients are

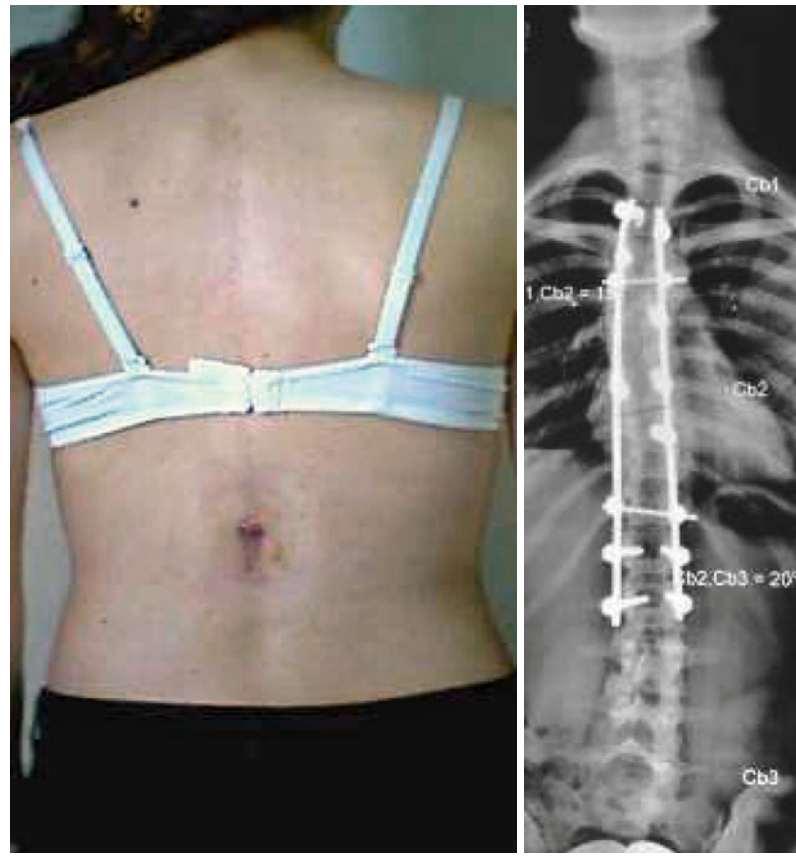

Fig. 6 Late infection with wound discharge after scoliosis surgery (3 years later)

more prone to it as well as how we can prevent it or safely treat it, are crucial steps. We sometimes assume this diagnosis based only on local pain, inflammatory changes or wound discharge and this is not reliable [28].

Aetiology and Epidemiology

Many surgeons would agree that post-operative infections are mainly the result of a surgical wound contamination inside the operating room or in the ward immediately after surgery and that the infecting agent often comes from the patient's own flora. The skin of all individuals accessing the operating room as well as the ward is generally recognised as a main source of all airborne organisms, so the more people we have inside the operating theatre the more organisms will be circulating. The surgical ability and sterile technique of the team also influence infection rates and this in spite of some reports that question whether post-operative infections are related to the experience of surgical staff [29]. Although we know that staphylococcus aureus or epidermidis are the most common infecting agents a significant number of cases still remain without an isolated agent and of course this creates additional difficulties [30]. Risk factors have to be carefully identified which seem to be multi-factorial and may be case-specific or patient-related ones. Obese people seem to be more prone to infection, wound drainage has a minor role and there is only indefinite evidence suggesting that pre-operative prophylactic antibiotics might improve infection rate even if we are not able to identify the most effective one or the right dosage [31]. Operative time, previous spine surgery, blood loss, tissue damage, diabetes, smoking, old age, rheumatoid arthritis,

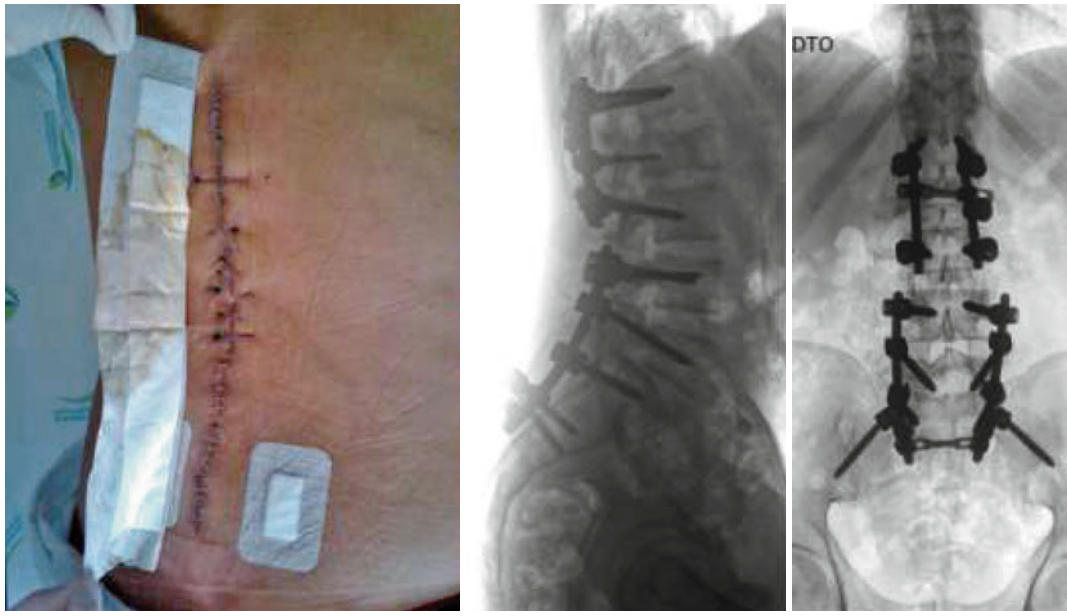

Fig. 7 Early infection and wound discharge after long spine stabilization in trauma patient treated with wide debridement and instruments preservation

steroid use or previous infection are all considered contributory [29, 31–33]. The use of implants might also incur in additional risk of wound infection at the insertion level [34] or even at the level above [35].

Spinal surgery has a higher infection rate then other surgeries such as total hip arthroplasty. However there is a wide variation (0.3–20 %) in reported infection rates after spine surgery [30, 34] and in the incidence of delayed infection which varies from 0.2 % to 6.7 % [28]. So there might be a correspondence between the complexity or increasing number of invasive surgical procedures and higher infection rates. We consider that revision surgery is more prone to infection than implant use and, on the other hand, minimally-invasive surgery is associated with less infection [30], although it takes more operative time. Since the cost of spinal treatments is always increasing, a significant reduction in risk factors would prove valuable, allowing surgeons to carefully identify them and act accordingly. There are inherent differences in hospital rates for per-operative spine infection across teaching and non-teaching hospitals [36] and that is important, as the consequences of a spinal infection include longer and more expensive hospital stays, a two-fold increase in mortality, a five-fold risk of hospital re-admission, and a 60 % greater chance of intensive care unit admission [29].

Treatment

Usually a post-operative spine infection is treated with multiple wide debridement primary or delayed wound closure and antibiotics for no less than 6 weeks. Different options have been suggested and the use of a vacuum-assisted wound closure is a possibility as it exposes the wound to negative pressures, removes fluid, improves blood supply and stimulates granulation tissue appearance providing good results in association with surgical debridement [37]. In the early stages implant removal is seldom necessary (Fig. 7) since implants can promote fusion and their removal might result in spinal instability and pseudarthrosis [32, 38]. Collins et al. [28] mentioned that there was

a confirmed 60 % deep wound infection on subsequent implant removal despite previous long-term antibiotics and wound surgical debridement, so they definitely recommended implant removal and reported 46 % of pain-free stable patients with this technique. When dealing with uncontrolled infection situations, Kim et al. [34] also found that implant removal associated with wide debridement was an effective option as far as controlling infection was concerned. However they also noted the appearance of disc collapse, loss of lordosis or pseudoarthrosis and this has to be taken into consideration. Implant removal has to be carefully evaluated since the advantage of the procedure might in time be overcome by its consequences.

Conclusions

Spinal infections can endanger patients either locally or systemically becoming an important generalised disease. In spite of being treatable conditions they can become life-threatening especially if not properly treated. A wide number of treatment modalities for each spinal infection have been suggested, from the non-surgical such as antibiotics and bracing to different types of surgery with anterior, posterior or combined procedures. Spondylodiscitis, tuberculosis and post-operative infections have to be carefully evaluated, realizing that the specific features of each case will define the best treatment strategy and that the efficacy of all treatments depends not only on the surgeon's ability but also on an early suspicion as well as meticulous handling of the available diagnostic tools.

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