Editorial
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The State-of-the-Art in treating infectious spondylitis

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Infectious spondylitis or spondylodiscitis is not uncommon clinically. It accounts for 2–7% of all cases of osteomyelitis. The predisposing factors include remote infections (e.g., urinary tract infection, gastrointestinal infection or infective endocarditis), immunocompromised states (e.g., diabetes mellitus, rheumatoid arthritis, or Cushing's syndrome), or a history of intravenous drug abuse or alcoholic. Diagnostic delay for infectious spondylitis is usually owing to its insidious and nonspecific clinical presentations. Plain radiography is insensitive to the early detect of spinal infection with normal radiologic appearance maintained for up to 4 weeks. The reported interval from the onset of symptoms to diagnosis was 4–6 months. The most common organisms causing pyogenic spondylitis include *Staphylococcus aureus* and *Streptococcus* species. However, mycobacterial or fungal infection can't be overlooked in the differential diagnosis of any spine infection.[1–5]

The diagnosis of spine infection is usually a long and tedious process. In pyogenic cases, a positive blood culture rate is only seen in 2/3 of the patients. In mycobacterial spondylodiscitis, the specificity of acid-fast stain was less than 30%. Furthermore, mycobacterial culture and drug susceptibility test were very time-consuming, a period of 6–8 weeks was usually required before a definite report available. In addition, the sensitivity of mycobacterial culture was reported as low as 50%. Clinically, the treatments of pyogenic or mycobacterial spondylitis mainly rely on antibiotic treatments. However, the optimal period of antibiotic administration is still an issue of debate. The recommended treatment period for pyogenic spondylitis is 4-6 weeks; and in mycobacterial spondylodiscitis, 1 to 1.5 years. Increasing drug resistance emerged in these patients is partly due to its prolonged and empirical antibiotic usage.

The key to achieve better clinical outcomes in treating spine infection is to obtain a reliable bacterial culture. Surgeons must have a high suspicion of it and initiate prompt and optimal treatments in order to achieve a successful outcome and less complications. Thus far, we may not forget that computed-tomography (CT-) guided biopsy and drainage are still the standard procedure to identify the causative pathogens. Most of spine infections can be managed non-surgically with a minimum of 4 to 6 weeks of antibiotic treatment especially in the early onset. Adjunctive brace or other supportive cares may also be needed. Surgical treatment is recommended when neurologic deficit occurs, spinal instability develops or only antibiotic therapy

fails to control infection. We were formally trained and academically taught that when the infection is located in the anterior spinal segment, anterior approach is practical. Classically, anterior debridement and interbody fusion with autogenous or allogenous bone graft is the standard treatment for spondylodiscitis, and additional one-staged or two-staged posterior instrumented fusion may be needed for spinal instability or deformity.[6–8]

However, for the surgical treatment of infectious spondylitis, will the anterolateral surgical approach to the anterior spine is still the ''gold standard''?[9,10] In the last 2 decades, with the aids of the modern optic equipment, refined surgical instruments and navigation technology,[11–17] innovative minimally invasive spine (MIS) techniques or endoscopic surgery can provide same or even better sequestrectomy of vertebral osteomyelitis, debridement of infected soft tissue and decompression of the thecal sac as open ones. It has been reported that percutaneous endoscopic debridement and drainage (PEDD) technique can be performed under local anesthesia with conscious sedation.[14,16,18] With this technique, the positive rate of the causative pathogens can be gained as high as 87.5% and is found more beneficial to the aged or patients with multiple comorbidities owing to its minimally invasiveness as compared to open surgery. Nowadays, the classical combined anterior and posterior procedures for spine infection has been challenged and gradually replaced by the less invasive procedures such as one-stage posterior costotransversecomy for thoracic lesions or transforaminal lumbar interbody debridement and fusion (TLIDF) for lumbar spine infection.[19] The reported clinical results were very encouraging.

Thus far, another issue of postoperative infection after spine surgery is taken more seriously as the various spinal instrumentations are more widely used. Postoperative spine infection has caused complicated spine problems with high morbidity and mortality and an increasing medicare cost.[20–23] A report based on 108,419 spine procedures from the Scoliosis Research Society Morbidity and Mortality Committee found a 1.2% incidence of deep wound infection after adult spine surgery. The infection rate after posterolateral spine fusion was 3%. Surgical management of a spine infection process was associated with a 5.1% risk.[20] Furthermore, it is reported that the number of MIS instrumented fusions performed in 2010 occupying 1/6 of the total number of all spine surgeries in the United States and 1/3 in 2016, which is anticipated to be greater than 1/2 in 2020.[23] It is impressive to know that MIS instrumented surgery did have a less deep wound infection rate, a shorter hospitalization day and was cost-effective as compared to open surgery.[22,24,25]

In this special issue, six papers, including 2 review articles, 3 original papers and 1 case report, were accepted for publication after a carefully blinded review by experts in spine field.

P.-Y. Chiu et al. have performed a systemic review and nicely summarized various surgical approaches and techniques for the treatment of spine infections. In terms of providing an easier surgical technique, a shorter surgical time, fewer complications and better clinical outcomes, the authors advocated that in their practice the posterior costotransversectomy approach is the first chosen approach in managing thoracic spondylodiscitis, and the TLIDF for the management of the thoracolumbar, lumbar and lumbosacral infections. Moreover, the anterior Smith-Robinson method with or without modified sternotomy is the most commonly used approach for spinal spondylodiscitis of cervical and cervicothoracic regions. They also highlighted the notion that an effective antibiotic treatment is the key of successful treatment for spine infections.

S.-H. Chen et al. have made an excellent and comprehensive review on the postoperative infections after spine surgery. Postoperative spine infections may lead to spondylodiscitis, pseudarthrosis, sepsis and poor outcomes if not be promptly aware and treated in a timely fashion. The authors pointed out that preserving the mechanically intact implants in early-onset postoperative infection is a legitimate strategy to permit fusion to occur. They also advocated that surgeons must always consider the patients' medical comorbidities, infection severity, bacteriology, treatment timing and spinal stability in choosing proper management strategies. In this article, the authors specially highlighted the notion regarding MIS surgery with infection as compared with open-TLIF (transforaminal lumbar interbody fusion). The safety and advantages of MIS-TLIF have been well documented based on its reduced tissue damage and dead space for blood accumulation for percutaneous pedicle screws fixation, less blood loss during cage insertion, and decreased hospitalization to lessen nosocomial contamination.

Chishih Chu et al. used the retrieved archival formalin-fixed paraffin-embedded (FFPE) vertebral specimen of 32 patients with vertebral osteomyelitis. Molecular analyses by a multiplex polymerase chain reaction (M-PCR) for detection of the causative genes were undertaken. All enrolled patients had received spine surgery along with a confirmed microbial culture at the affected site and a compatible histo-pathological finding. In this study the authors validated the effectiveness of a 2-step M-PCR assay in detecting *M. tuberculosis* in FFPE. They found that the current 2-step M-PCR assay had a 91.7% of the sensitivity, 90% of the specificity, 84.6% of the positive predictive value, and 94.7% of the negative predictive value. The accuracy rate was 90.1%. The authors concluded that the current 2-step M-PCR assay is sensitive and effective in

detecting *M. tuberculosis* in FFPE vertebral specimen. Potentially, this 2-step M-PCR can be applied as a quick and valuable supplementary tool for increasing the diagnostic accuracy of tuberculous spondylitis.

C.-M. Chang et al. retrospectively reviewed the surgical outcomes of 27 patients with spondylodiscitis after combined anterior and posterior spine surgeries, with a follow-up of at least 4 years. In this study, there were 5 in thoracic group and 22 in lumbar group, with a mean age of 56.9 years. They found all the patients achieved definite radiographic fusion by 1 year after surgery. The Oswestry Disability Index score in the lumbar group and Nurick score in the thoracic group significantly improved after surgery. The sacropelvic sagittal parameters were improved and without pseudarthrosis were observed at the 2-year follow-up. The authors concluded that anterior interbody fusion with strut bone grafting and posterior instrumentation was an effective method for the treatment of pyogenic spondylodiscitis at the medium-term follow-up.

S.-C. Yang et al. reported on the clinical and radiographic results of 12 patients with complicated infectious spondylitis treated by a single-stage anterior debridement and reconstruction using titanium mesh cage (TMC) followed by an immediate posterior instrumentation. The mean age was 55.9 years and with a follow-up of at least 36 months. They found that the average visual analog scale score significantly decreased after surgery (from 7.3 to 3.3). The average Cobb's angle correction was 14.5 degrees. The neurologic status was significantly improved after surgery. There were no implant breakage or TMC dislodgement. The authors concluded that good functional outcomes and low complication rate were achieved by this approach which could be applied as an alternative method to manage the patients with complicated infectious spondylitis.

M.-H. Hsieh and J.-T. Chien reported on an innovative, less invasive surgical technique to evacuate panspinal epidural abscess, at least 15 vertebral levels from cervical to lumbosacral region, by limited laminectomy of few levels and suction-irrigation in 4 patients. The authors highlighted the notion that multiple levels of epidural abscess can be successfully treated by limited lumbar laminectomy followed by using an 8-Fr infant nasogastric feeding tube to drain the abscess. Four patients were successfully treated and with an improved neurologic function, without dura tear or surgical complications at a minimum of 3-year follow-up.

To date, we may say that the "state-of the-art" standard of care in spine infection is still in its evolving stage. Current practices have revealed a trend of a shift of the classical combined anterior and posterior surgery to a one-stage posterior only approach. Furthermore, the less invasiveness of PEDD technique has already been adopted to treat spine infections in many medical centers. However, several issues such as a need of training in anterior spine surgery when conversion to open surgery is necessary, a learning curve of endoscopic techniques, the cost-effectiveness and potential complications still require constant analyses.

The author would like to give special thanks here to all the authors for submitting their valuable works to this special issue. Hopefully, the readers could read each paper with an open and critical mind, get some inspirations from the published articles and benefit to your clinical practice.

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