of greater than eight weeks as a predictor of lower recovery rates, neurologic deficits and long-term disability [2–4]. A recent study by Issa et al. demonstrated that the percent of positive cultures from blood and/or biopsy decreases as the delay in diagnosis increases [2–5].

Jean et al. looked at predictors of delayed diagnosis and found that X-rays resulted in an increased delay from 14 days to 34.7 days [6]. It is presumed that, although delaying diagnosis, X-ray findings (either normal or demonstrating degenerative changes) provide the physician with reassurance. Alternatively, Jean et al. found that fever at initial presentation, elevated C-reactive protein (CRP) and blood cultures shortened the time to diagnosis [6]. The most significant impact was the elevated CRP which shortened the diagnostic delay from 73 days to 17 days [6]. It is therefore suggested that CRP be routinely checked in cases of new onset or sudden increased back pain [6,7]. Furthermore, if CRP is elevated or if there is clinical suspicion for spine infection, MRI with gadolinium should be performed [8].

REFERENCES

[1] Cottle L, Riordan T. Infectious spondylodiscitis. J Infect. 2008;56:401–412. doi:10.1016/j.jinf.2008.02.005.

[2] McHenry MC, Easley KA, Locker GA. Vertebral osteomyelitis: long-term outcome for 253 patients from 7 Cleveland-area hospitals. Clin Infect Dis. 2002;34:1342–1350. doi:10.1086/340102.

[3] O'Daly BJ, Morris SF, O'Rourke SK. Long-term functional outcome in pyogenic spinal infection. Spine. 2008;33:E246–E253. doi:10.1097/BRS.0b013e31816b8872.

[4] Solis Garcia del Pozo J, Vives Soto M, Solera J. Vertebral osteomyelitis: long-term disability assessment and prognostic factors. J Infect 2007;54:129–134. doi:10.1016/j.jinf.2006.01.013.

[5] Issa K, Pourtaheri S, Vijapura A, Stewart T, Sinha K, Hwang K, et al. Delay in diagnosis of vertebral osteomyelitis affects the utility of cultures. Surg Technol Int. 2016;29:379–383.

[6] Jean M, Irisson J-O, Gras G, Bouchand F, Simo D, Duran C, et al. Diagnostic delay of pyogenic vertebral osteomyelitis and its associated factors. Scand J Rheumatol. 2017;46:64–68. doi:10.3109/03009742.2016.1158314.

[7] Siemionow K, Steinmetz M, Bell G, Ilaslan H, McLain RF. Identifying serious causes of back pain: cancer, infection, fracture. Cleve Clin J Med. 2008;75:557–566.

[8] Dunbar JA, Sandoe JA, Rao AS, Crimmins DW, Baig W, Rankine JJ. The MRI appearances of early vertebral osteomyelitis and discitis. Clin Radiol. 2010;65:974–981. doi:10.1016/j.crad.2010.03.015.

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QUESTION 3: Is there an optimal window for diagnosis of an early spine infection?

RECOMMENDATION: There is no defined window, but early diagnosis of a postoperative spine infection (up to three months from time of surgery) treated with surgical debridement and antibiotics often allows for retention of instrumentation.

LEVEL OF EVIDENCE: Limited

DELEGATE VOTE: Agree: 93%, Disagree: 7%, Abstain: 0% (Super Majority, Strong Consensus)

RATIONALE

Although the evidence regarding this topic is from low-quality studies, the findings and recommendations are consistent. Most postoperative spinal infections in adults present early, typically within the first three months [1]. Early diagnosis and debridement typically allows for retention of implants when present [1]. Implant removal due to infection can result in satisfactory results and eradicate infection, but can lead to malalignment and pseudarthrosis [2].

Early spine infections (< three months after surgery) treated with irrigation and debridement have improved outcomes compared to before surgery, but cause increased back pain and a lower probability of achieving a minimal clinically important difference [3].

In a cohort study of 51 patients who developed a postoperative spinal implant infection, prompt treatment (< 3 months) with debridement allowed for implant preservation in 41 patients, versus 10 patients in which treatment was delayed and implants were removed [4]. Another case series identified 26 postoperative infections, of which 24 were able to be treated without removal of implants by aggressive debridement and secondary closure [5]. Early identification and treatment can often allow for implant retention compared to delayed presentation, when implants may need to be removed [6–8].

Late spine infections are, however, seen more commonly in idiopathic scoliosis cases [9]. In a case-controlled series of 236 patients, seven developed an infection [10]. One was early and the other six were diagnosed at an average of 34.2 months postoperatively.

It is typical for patients to have symptoms of low back pain for 4 to 10 weeks prior to diagnosis of spondylodiscitis [11,12]. Although most studies recommend early treatment, no specific timeframe could be identified that definitely leads to better outcomes.

REFERENCES

[1] Mok JM, Guillaume TJ, Talu U, Berven SH, Deviren V, Kroeber M, et al. Clinical outcome of deep wound infection after instrumented posterior spinal fusion: a matched cohort analysis. Spine. 2009;34:578–583. doi:10.1097/BRS.0b013e31819a827c.

[2] Kim J Il, Suh KT, Kim SJ, Lee JS. Implant removal for the management of infection after instrumented Spinal Fusion. J Spinal Disord Tech. 2010;23:258–265. doi:10.1097/BSD.0b013e3181a9452c.

[3] Petilon JM, Glassman SD, Dimar JR, Carreon LY. Clinical outcomes after lumbar fusion complicated by deep wound infection: a case-control study. Spine. 2012;37:1370–1374. doi:10.1097/BRS.0b013e3182a4d93.

[4] Chen SH, Lee CH, Huang KC, Hsieh PH, Tsai SY. Postoperative wound infection after posterior spinal instrumentation: analysis of long-term treatment outcomes. Eur Spine J. 2015;24:561–570. doi:10.1007/s00586-014-3636-9.

[5] Picada R, Winter RB, Lonstein JE, Denis F, Pinto MR, Smith MD, et al. Postoperative deep wound infection in adults after posterior lumbosacral spine fusion with instrumentation: incidence and management. J Spinal Disord. 2000;13:42–45. doi:10.1097/00002517-200002000-00009.

[6] Glassman SD, Dimar JR, Puno RM, Johnson JR. Salvage of instrumental lumbar fusions complicated by surgical wound infection. Spine (Phila Pa 1976). 1996;21:2163–2169. doi:10.1097/00007632-199609150-00021.

[7] Kowalski TJ, Berbari EF, Huddleston PM, Steckelberg JM, Mandrekar JN, Osmon DR. The management and outcome of spinal implant infections: contemporary retrospective cohort study. Clin Infect Dis. 2007;44:913–920. doi:10.1086/512194.

[8] Bose B. Delayed infection after instrumented spine surgery: case reports and review of the literature. Spine J. 2003;3:394–399. doi:10.1016/S1529-9430(03)00023-8.

[9] Richards BS, Emara KM. Delayed infections after posterior TSRH spinal instrumentation for idiopathic scoliosis: revisited. Spine. 2001;26:1990–1996. doi:10.1097/00007632-200109150-00009.

[10] Rihn JA, Lee JY, Ward WT. Infection after the surgical treatment of adolescent idiopathic scoliosis: evaluation of the diagnosis, treatment, and impact on clinical outcomes. Spine. 2008;33:289–294. doi:10.1097/BRS.0b013e318162016e.

[11] Bettini N, Girardo M, Dema E, Cervellati S. Evaluation of conservative treatment of non specific spondylodiscitis. Eur Spine J. 2009;18. doi:10.1007/s00586-009-0979-8.

[12] Valancius K, Hansen ES, Hoy K, Helmig P, Niedermann B, Bünger C. Failure modes in conservative and surgical management of infectious spondylodiscitis. Eur Spine J. 2013;22:1837–1844. doi:10.1007/s00586-012-2614-3.

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QUESTION 4: How do early and late infectious complications differ following spine surgery?

RECOMMENDATION: Early infections, defined as occurring within 30 days of surgery, often present with local signs of infection such as increased surgical site pain, erythema, warmth and wound drainage. Conversely, late infections (> 90 days after surgery) commonly present with an insidious onset of chronic pain and implant failure/ pseudarthrosis if following a fusion.

LEVEL OF EVIDENCE: Moderate

DELEGATE VOTE: Agree: 87%, Disagree: 0%, Abstain: 13% (Super Majority, Strong Consensus)

RATIONALE

Postoperative spine infection occurs at a rate of 0.7–16% depending on the procedure; the lumbar spine is the site of 51% of infections [1].

A postoperative infection is classified as early when it occurs within 30 days of the initial surgery. Early infections typically present with increasing back pain (83–100%) as the primary symptom [2,3]. Fever, weight loss, erythema, swelling, warmth, tenderness and elevated white blood cell (WBC) count may also be present, with fever having an incidence of 16–65% [2–4]. One of the most reliable and specific signs of early infection is increased wound drainage (67%) as it can occur in both deep and superficial infections [4].

A postoperative infection occurring three to nine months following surgery can be classified as a late infection. As opposed to early infections, late infections typically present with delayed symptoms such as lack of adequate fusion, chronic pain or implant failure months after surgery [5]. Local symptoms may also occur, including increased pain and tenderness at the incision site. Wound drainage may occur but is less common than in early infections [5].

Complications of postoperative spine infection include impairment of function, significant morbidity and increased health care costs approximating up to $200,000 per patient [1,3]. Increase in hospital stay and increased rates of repeat surgery have also been observed.

Gram-positive bacteria, specifically *Staphylococcus aureus,* are responsible for approximately 45% of spine infections [6]. Other gram-positives such as *Staphylococcus epidermis* and *Enterococcus* as well as gram-negatives *Pseudomonas aeruginosa* and *Escheria coli* have been observed at lower incidences [1,2,6]. There is no clear association between type of surgical procedure and bacteria strain. However, gram-negatives tend to present more commonly in sacral and lumbar regions [6]. Fungal infections may occur in immunocompromised patients. *C. acnes* has recently been identified as another potential causative organism [2]. No significant difference has been observed in the type of organism present in early and late infections.

REFERENCES

[1] Pawar A, Biswas S. Postoperative spine infections. Asian Spine J. 2016;10:176–183.

[2] Chahoud J, Kanafani Z, Kanj S. Surgical site infections following spine surgery: eliminating the controversies in the diagnosis. Front Med (Lausanne). 2014;1:17.

[3] Parchi P, Evangelisti G, Andreani L. Postoperative spine infections. Orthop Rev. 2015;7(3):5900.

[4] Kasliwal MK, Tan LA, Traynelis VC. Infection with spinal instrumentation: review of pathogenesis, diagnosis, prevention, and management. Surg Neurol Int. 2013;4(Suppl 5):S392.

[5] Radcliff K, et al. What is new in the diagnosis and prevention of spine surgical site infections? Spine J. 2015;15:336–347.

[6] Abdul-Jabbar A, et al. Surgical site infections in spine surgery: identification of microbiologic and surgical characteristics in 239 cases. Spine. 2013;38:E1425–E1431.

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QUESTION 5: Are there patients with degenerative pathology, such as disc herniations, who are actually infected with a low-grade infection (e.g., *Propionibacterium acnes*)?

RECOMMENDATION: The association between the *Cutibacterium acnes (C. acnes)* (formerly *P. acnes*) and degenerative spinal disease is inconclusive.

LEVEL OF EVIDENCE: Limited

DELEGATE VOTE: Agree: 86%, Disagree: 14%, Abstain: 0% (Super Majority, Strong Consensus)