

## Management of Post Operative Disc Space Infection

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**Abstract: Background:** Disc space infection is a significant complication after discectomy and is associated with significant morbidity. Surgical wound infection remains the second most common type of nosocomial infection. **Objective:** The objective of this study was to evaluation of different methods of management of post operative disc space infection. **Subjects and Methods:** This is a retrospective analysis of patients who underwent lumbar laminectomy and discectomy over a period of 6 months was conducted. In the 6month period, 20 patients underwent surgical procedures for disc prolapse. **Results:** There was all patients who were enrolled in the study had received a clinical diagnosis of a POD, on the basis of clinical, laboratory, and radiographic findings. The surgical procedure and the postoperative course of all the patients were uneventful. They had experienced good relief of symptoms immediately after surgery during 6 months of study We had total 20 patients who underwent lumbar discectomy. All patients had moderate to severe back pain. **Conclusions:** POD is a serious complication of disc surgeries. Discitis should be suspected in all patients with unexplained persistent back pain beyond 2 weeks of surgery or any other exaggerated symptoms. Careful evaluation is required in such cases. The diagnosis is made on clinical suspicion, raised ESR. C-reactive proteins and signal changes in disc spaces on MRI. [Abd Elkafy Sharaf Eldin Ibrahim, Ahmed Mohammed Abdul Rahman Tahoun, Maamoun Mohammed Abo Shosha and Ayman Elsaed Afifi. **Management of Post Operative Disc Space Infection.** *Nat Sci* 2017;15(9):25-35]. ISSN 1545-0740 (print); ISSN 2375-7167 (online). <http://www.sciencepub.net/nature>. 5. doi:[10.7537/marsnsj150917.05](https://doi.org/10.7537/marsnsj150917.05).

**Keywords:** Management; Post Operative Disc Space; Infection

### 1-Introduction

Disc space infection is a significant complication after discectomy and is associated with significant morbidity. Surgical wound infection remains the second most common type of nosocomial infection, and accounts for almost one-third of all hospital acquired infections. (Eltahawy AT., et al 1992).

Known risk factors for infection include diabetes, obesity, rheumatoid arthritis, long-term steroid use, alcohol abuse, poor nutrition, smoking, prior infection, prior spinal operations, extended preoperative hospitalization, posterior approach.

Staphylococcus is the most common organism which causes pyogenic discitis, followed by aerobic gram negative bacilli and rarely fungal infections Clostridium perfringens, Haemophilus species and Aspergillus fumigatus. (Hamdan TA, 2012).

The characteristic symptoms were severe spinal pain Pain is the common symptom of discitis, which is constant pain that becomes worse at night ( Torda AJ, et al., 1995).

The key physical findings were paravertebral muscle spasm and limited spinal mobility.

Fever is less common. Only in rare cases patient complaint of constitutional symptoms, such as fatigue, malaise ( Mylona E, et al., 2009).

The diagnosis based on the history, physical examination, laboratory study like- ESR, C-reactive

protein and blood culture and imaging studies like plain radiographs, computed tomography (CT), magnetic resonance imaging, (MRI) is the most important imaging modality for evaluating postoperative spinal infection (Roberts FJ, et al., 1998).

The majority of patients are managed adequately with culture specific antibiotics and spinal immobilization Majority author believe that immobilization with orthosis with intravenous administration of specific antibiotics for six weeks followed by additional weeks of oral antibiotics (Fouquet B, et al., 1992).

Surgery is indicated in those patients who infection has progressed on MRI despite appropriate antibiotic therapy, with deformity due to progressive destruction of the vertebral bodies (Silber JS, et al., 2002).

### Aim of the Work

Evaluation of different methods of management of post operative disc space infection.

### 2. Materials and Methods

A retrospective analysis of patients who underwent lumbar laminectomy and discectomy over a period of 6 months was conducted. In the 6month period, 20 patients underwent surgical procedures for disc prolapse.

Patients who presented with features of post operative disc space infection, with severe back pain after lumbar disc surgery were included in the study. They had positive straight leg raising test and restricted movements on examination. Blood tests, X-ray, magnetic resonance imaging (MRI) erythrocyte sedimentation rate (ESR), C-reactive protein (CRP), white blood cell count (WBC) were used to confirm diagnosis.

Patients received conservative management with antibiotics, analgesics, physiotherapy and complete bed rest.

Patients with improved symptoms and lab investigations continued to be managed conservatively some patients were selected for surgery that included posterior interbody fusion after debridement.

The diagnosis of discitis was established when all three of the following criteria were present.

1- Clinical symptoms and signs: recurrent low back pain, decreased back motion, paravertebral muscle spasm, and positive bed-shaking test (pain can be aggravated by shaking the bed back and forth).

2-Laboratory findings of elevated ESR, CRP, and WBC values. **Sampling:** 5ml of serum blood taken for each subject. 1 ml in edeta tube for WBC, 1.6 ml added to 0.4 ml sodium citrate 3.8% for ESR detection by (Westerngreen method) & the balance will put in plain tube & serum is prepared for CRP.

CRP determination by (BioSystems Cod 31113) with Turbidimetric method.

**Sampling:** Serum collected by standard procedures. CRP in serum is stable for 7 days at 2-8 c.

**Procedure:**

-Bring the working reagent and the instrument 37c.

Zero the instrument with distilled water.-

-Pipette into a cuvette: Working reagent, 1.0ml. Standard or Sample 7ul-

Mix and immediately insert cuvette into the instrument. Start stopwatch-

-Record the absorbance at 540 nm after 10 second (A1) and after 2 minute (A2).

MR imaging findings compatible with discitis.

Some patients had undergone open discectomies as a method of treatment for symptomatic prolapsed lumbar discs, which was complicated by infection in the operated disc spaces.

Conservative treatment with broad spectrum antibiotics. The antibiotic regimen was chosen to cover gram positive, gram negative and anaerobic organisms. Total 6 weeks of antibiotic therapy (3weeks iv + 3weeks oral) along with limited analgesics given for all patients. Antibiotic protocol: I.V Linezolid/Vancomycin+amikacin+ornidazole.

The new anti-staphylococcal agent "linezolid" has good penetration into bone and excellent oral bioavailability, characteristics that are desirable in the treatment of bone infections.

Oral agents should have high bioavailability and possible options include fluoroquinolones, clindamycin, rifampicin and fusidic acid.

After 2 weeks of initiation of therapy showing decreased levels ESR and c reactive protein. At the end of 6 weeks antibiotic therapy, patients had symptomatic relief. Psychological support given to all patients.

Despite adequate and prolonged conservative treatment, the nine patients studied continued to suffer from significant low back pain, the average severity of which, assessed by the visual pain analogue scale.

Plain radiographs revealed disc space narrowing with erosion and sclerosis of the adjacent end-plates in all cases. Accordingly, those patients were treated by one stage surgical debridement, TLIF and posterior instrumentation.

In most patients the infection is often mild, self-limited and will resolve spontaneously without any treatment intervention. In many cases, there may be a delay in diagnosis because of the frequent occurrence of back pain after spinal surgery. Transient L5 nerve root palsy in one patient, which resolved spontaneously over approximately 4 months.

One other patient had wound infection which was cured in 3 weeks, by repeated dressings in addition to the routinely administered antibiotics. There were no other notable complications related to the procedure.

In the treatment of spondylodiscitis, numerous authors have preferred to recommend bed rest and prolonged spinal bracing rather than surgical intervention. Others have advocated a staged operation with a period of antibiotic therapy bridging the debridement and instrumentation procedures. Broad-spectrum antibiotics are typically initiated after surgery. Antibiotic therapy is routinely continued for at least 6 weeks, and any subsequent changes in medical management are based on the clinical response and laboratory profile of each patient. Management of postoperative discitis often begins conservatively. If discitis is suspected on the basis of laboratory studies or imaging findings, broad-spectrum antibiotics should be used.

If there is clinical evidence that the infection is worsening, or if symptoms do not resolve after 6 weeks of antibiotic treatment, open surgical intervention should be considered. Surgical debridement usually involves removal of the disk and aggressive anterior debridement of necrotic tissue and bone.

**Steps of surgical treatment:**

Debridement and Abscess Drainage-  
-Reconstruction: of destroyed vertebral body to correct kyphotic deformity due to vertebral collapse.

Instrumentation and fusion-

-Management of postoperative spinal infections after placement of instrumentation.

**Spinal instrumentation may be:**

-Anterior instrumentation: (spacers with or without plates and screws)

-Posterior instrumentation: like rods.

Combined-

Open surgical drainage for spondylodiscitis was historically reserved for patients with an epidural abscess. The prognosis is stated to be better when treatment is instituted early during the infection. There are no obvious advantages to avoidance of hardware placement into debridement cavities. Indeed, the reported sporadic cases of extrusion of anteriorly placed grafts indicate that fixation should be used if possible.

Surgery for the cases of POD was done through the posterior approach. Reexploration debridement and curettage of disc space granulation tissue with inter transpedicular fixation was conducted in all cases. Surgery in POD at the L4/5 and L5/S1 levels through the anterior approach is quite difficult and morbidity is also high. But the disc space can be approached more easily from the posterior side. Arthrodesis and internal fixation can be used as surgical management of pyogenic discitis with vertebral osteomyelitis without much complication.

In our study 20 patients, 9 patients improved on conservative treatment, the other 11 patients were re-explored after poor response to conservative treatment and concluded that early re-exploration is superior to prolonged conservative treatment. Surgical management in the form of transpedicular fixation were 7 patients and debridement were 4 patients, when required, gives excellent results.

	Age	Sex	Level	WBC	ESR	CRP
1	50	F	L5-S1	11.2	55	15
2	63	F	L3-4	10.9	60	56
3	55	F	L4-5	12.6	30	66
4	48	M	L5-S1	13.4	45	103
5	45	F	L3-4	11.9	67	20
6	50	F	L5-S1	14.3	54	35
7	59	F	L4-5	14.9	40	49
8	57	F	L4-5	12.5	60	57
9	52	M	L3-4	15.66	56	76
10	49	M	L5-S1	10.8	54	54
11	45	F	L4-5	12.1	76	76
12	47	F	L5-S1	15.6	60	90
13	60	M	L3-4	13.9	90	53
14	62	M	L4-5	11.9	55	36
15	44	M	L5-S1	16.3	60	82
16	46	M	L4-5	17.9	46	66
17	60	F	L3-4	14.8	70	78
18	59	F	L5-S1	13	100	67
19	60	M	L4-5	16.5	85	48
20	58	M	L3-4	8.5	38	30

### 3. Results

All patients who were enrolled in the study had received a clinical diagnosis of a POD, on the basis of clinical, laboratory, and radiographic findings.

The surgical procedure and the postoperative course of all the patients were uneventful. They had experienced good relief of symptoms immediately after surgery.

During 6 months of study We had total 20 patients who underwent lumbar discectomy. All patients had moderate to severe back pain. The pain was described as continuous and deep-seated and was frequently associated with morning stiffness.

It was accompanied by severe paravertebral muscle spasm, and was radiating into the buttocks, thighs, groin, perineum or the abdomen. Typically, it was easily exacerbated by any motion, or attempts at

examination. It was noteworthy that, bed-shaking test was positive in all patients, regardless of their clinical grade. Neurological examination revealed that none of these patients had neurological deterioration comparing with the preoperative findings.

Straight leg raising tests were positive at small angles. The surgical skin incision appeared to heal uneventfully in all patients. Local erythema, swelling, or a draining sinus were not seen.

ESR, C- reactive proteins and MRI lumbar spine were done.

ESR and CRP values were increased in all patients. The highest ESR ranged between ( 30-100) mm/hour, and the highest CRP values ranged between ( 15-103) mg/L. WBC ranged between (8.5 -17.9) mm<sup>3</sup>.

Initially obtained plain radiographs showed little evidence of intervertebral discitis. There was some decrease in disc height (however this frequently accompanies discectomies).

The intervertebral disc spaces were narrowed in all patients. Vertebral edema was also present patients. This was particularly important in differential diagnosis of the patients who had the diagnosis of discitis in the first week after surgery, because, in the early postoperative setting, the absence of vertebral edema has strong negative predictive value for infectious discitis.

The characteristic MRI findings of discitis in the acute stages were found in all of the patients. The involved intervertebral disc space and adjacent vertebral bodies were visualized.

No relation was noticed between the size of the disc herniation and the incidence of infection, but prolonged surgery due to adhesion between the root, disc and dura or in bilateral exploration (right and left) was a factor leading to infection. Also, the incidence of infection was greater at the level L4-L5. Re-exploration was done from the posterior approach, and none of the cases studied required anterior fusion.

All patients were advised complete bed rest. They were started on analgesics, oral or intravenous antibiotics. conservatively and the rest needed exploration. patients showed improvement with conservative management on regular follow-up.

All these patients had posterior exploration of which patients needed transpedicular fixation.

Patients were treated conservatively with bed rest and antibiotics and needed exploration with antibiotics. All these patients had posterior exploration patients needed transpedicular fixation (TPF).

The most common combination of antibiotic medications initially selected consisted of intravenous. The duration of administration of intravenous antibiotic medications was 6 weeks, the duration of

using lumbar drain on the two patients was 2 weeks without spread of infection.

Dramatic improvement of wound after debridement with safety margin the wound heal duration was 4-6 weeks after debridement, ESR gradually decrease.

MRI images performed after completion of the treatment and sequential MRI's performed in the follow-up period showed progressive increase in signal intensity within the disc and adjacent vertebral body marrow. However, radiological decline of inflammatory symptoms appeared to come after the improvement of clinical and laboratory findings.

During their treatment, none of the patients suffered neurological deterioration. In the majority of the patients, elevated ESR/CRP values returned to the preoperative baseline values within 8 to 30 days after initiation of the treatment.

The preoperative diagnosis of patients who subsequently developed infections consisted predominantly of degenerative spinal disorders. The mean number of surgeons was 3 in each patient. The number of vertebrae spanned by the instrumentation was 2 to 3 levels.

The most common clinical presentation was a partial wound dehiscence associated with the drainage of purulent fluid, Pain, redness around the wound and fever Severe Back pain. Wound infections were assessed by laboratory analysis of including a complete blood count. Mean white blood cell count, Erythrocyte sedimentation rate, C reactive protein and all investigation were positive for infection.

#### 4. Discussion

Discitis after surgical treatment for disc prolapse. Post operativediscitis (POD) can be either septic or aseptic. Many studies showed that it could be due to bacterial causes (**Osti OL., et al., 2014**).

In our study patients had POD over a period of 6 months Occurrence of discitis was high in patients with recurrent disc surgeries as previously reported.

Clinical presentation in most of the cases in our study was similar to the existing literature. The characteristic symptoms in our cases were severe increasing back pain, muscle spasm and fever; radicular pain was also a common finding. (**Ahmad M., et al., 2010**).

The first step in the management of any infective process is to establish a bacteriological diagnosis. The literature on postoperative disc space infections clearly indicates that this poses difficulties. (**Luzzati R., et al., 2009**).

Early and accurate diagnosis of discitis that correlates with clinical, laboratory and radiological findings is required. Persistent elevated ESR and CRP together with typical findings in MRI suggests

discitis. Increased ESR and CRP are suggestive but not confirmatory of the diagnosis. CRP typically declines by around 10 days postoperatively, hence any patient with unexpected rise in CRP beyond 2 weeks postsurgery should be suspected for POD (**Boden SD., et al., 1992**).

Some studies indicate that CRP is the most sensitive indicator of POD X-ray findings shows-Narrowing of disc space with end plate irregularities.

Clinical MRI is the most superior diagnostic method. MRI reportedly has good sensitivity and specificity. Florid inflammatory signs with granulation tissue were identified on MRI in most of our cases, as previously reported (**Wirtz DC., et al., 2000**).

This author indicated that with widened experience in management, and he relied upon antibiotics and immobilization., he recommended that antibiotics should be continued until the ESR returned to normal, a recommendation concerning which we have some reservations. Our experience leads us to conclude that attempts at bacteriological diagnosis should be conditioned by the clinical picture (**Perlmutter, D., et al., 1998**).

An obvious wound infection is unusual, but here a bacteriological diagnosis is readily established (Cases 4 and 12) with early diagnosis, antibiotic therapy is on a sound basis.

The antibiotic treatment is strengthened if the patient has a constitutional reaction-fever, leucocytosis, and so on, but this is uncommon. Notwithstanding the importance of antibiotics in such instances, immobilization does appear to be the cornerstone of management, and it produces a dramatic relief of the severe, often agonizing, back pain which is so characteristic of this complication.

Case 4, would, by present criteria, be managed surgically by anterior debridement. This patient was seriously ill with an obvious wound infection, high fever, and marked bony destruction (**Thibodeau., et al., 2002**).

In feeling that posterior exploration has little to offer when drainage/debridement is indicated, and that an anterior approach is far more efficacious.

The antibiotics in patients who present late is more open to question. Our analysis of the data leads us to conclude that immobilization alone is probably all that is required, though failure to respond to this measure, which did not occur in the present series, could alter the situation. Once sclerosis is established in the healing phase, it seems unlikely that antibiotics will reach the avascular disc space in a significant concentration, but there is no information available to support this somewhat speculative contention. (**Ford., et al., 2011**)

Thus, empirical antibiotic management is the only treatment course when identification of the causative pathogen is lacking. In our study, antibiotic treatment was started in all cases and the patients showed fall in ESR and CRP levels with clinical improvement. There is no standardised management protocol for discitis.

Complete bed rest and antibiotics remain the main stay of management. Conservative treatment and spinal immobilisations yield good outcomes in most cases (**Dall BE., et al., 2013**).

Some cases presented with symptoms even after conservative management. Hence, the cases were finally selected for surgery.

Surgery for the cases of POD was done through the posterior approach. Reexploration debridement and curettage of disc space granulation tissue with inter transpedicular fixation was conducted in all cases. Surgery in POD at the L4/5 and L5/S1 levels through the anterior approach is quite difficult and morbidity is also high. But the disc space can be approached more easily from the posterior side. Instrumentation helps in stabilising the infected spine more effectively and hastens the healing process (**Rayes M., et al., 2010**).

Another study by Przybylski and Sharan reported that single stage debridement, arthrodesis and internal fixation can be used as surgical management of pyogenic discitis with vertebral osteomyelitis without much complication (**Przybylski GJ., et al., 2001**).

## Conclusions

POD is a serious complication of disc surgeries. Discitis should be suspected in all patients with unexplained persistent back pain beyond 2 weeks of surgery or any other exaggerated symptoms. Careful evaluation is required in such cases.

The diagnosis is made on clinical suspicion, raised ESR•

C-reactive proteins and signal changes in disc spaces on MRI•

Early diagnosis and appropriate management lead to a good prognosis. Conservative treatment with complete bed rest and proper antibiotic therapy itself is the main stay of management in majority of cases. Surgical treatment including debridement, fixation and fusion is required if conservative management fails. The prognosis of discitis is good in most cases without major complications.

## References

1. Agarwal R, Williams K, Umscheid CA. (2009): Osteoinductive bone graft substitute s for lumbar fusion. In a systematic review: J Neurosurg Spine. 11(6):729-740.

2. Ahmad M, Yasin M. Lumbar discitis (2010): prevalence and management after lumbar disc surgery. *Prof Med J* 17:628-632.
3. Al-Sukhun J, Helenius M, Lindqvist C (2007): The Use of platelet rich plasma (PRP) in the reconstruction of mandibular bony defects. In *Clinical and radiographic follow-up.*: *Br J Oral Maxillofac Surg.*
4. Jan6. American Association of Neurological Surgeons. Posted (30/ 12/2004).
5. An H, Simpson M, Glover M and Stephany J. (2002): Comparison between allograft plus demineralized bone matrix versus autograft in anterior cervical fusion: *Spine*: 20: 22 11- 22 16.
6. Anton E, Fernandez C, Barragan OM (2004): Spontaneous spondyl -odiscitis caused by bacteroides uniformis. *AM J MED*, 15; 117(4): 284-6. Aoki Y, Yamagata M, Nakajima F: Posterior migration of fusion cages in Degenerative lumbar disease treated with transforaminal lumbar inter body Fusion: a report of three patients.: *Spine*: 2009: 34: E54-E58.
7. Aoki Y, Yamagata M, Nakajima F (2009): Posterior migration of fusion cages in degenerative lumbar disease treated with transforaminal lumbar interbody fusion: a report of three patients.: *Spine*: 34: E54-E58.
8. Arias F, Mata-Essayag S, Landaeta ME, ET AL (2004): *Candida albicans* osteomyelitis: case report and literature review. *International Journal of Infectious Diseases*; 8, 307-3 14.
9. Aurori B, Weierman R, Lowell H, Nadel C, Parson J (2003): Pseudarthrosis after spinal fusion for scoliosis. In a comparison of autogeneic and allogeneic bone grafts. *Clin Orthop*;; 19: 153- 158.
10. Balcerzak M, Pikula S, Buchet R (2006): Phosphorylation - dependent phospholipase D activity of matrix vesicles. *FEBS Lett. Oct*; 580(24):5676-80.
11. Bax HI, Van Veelen MC, Gyssens IC, Rietveld AP (2007): Brucellosis, an uncommon and frequently delayed diagnosis. *Netherlands journal of medicine*.65:9:352-355.
12. Belzunegui J, Intxausti De Dios JR, JJ, et al (2000): Haematogenous vertebral osteomyelitis in the elderly. *Clin Rheumatol* 19: 344-347, 2000. Benzel E, Lastra J, Kalfas J: The biomechanics of interbody fusion and the shortcomings of lumbar fusion with cages and interbody bone dowels.: *Clinical Neurosurgery*::47:557 -588.
13. Boden SD, Davis DO, Dina TS, Sunner JL, Wiesel SW. *Postoperative diskitis (1992): distinguishing early MR imaging findings from normal postoperative disk space changes. Radiology* 184:765-71.
14. Boden S, Martin G, Morone M, Ugbo J and Moskovitz P. (2007): Posterolateral lumbar intertransverse process spine arthrodesis with recombinant human bone morphogenetic protein -2/hydroxyapatite- tricalcium phosphate after laminectomy in the nonhuman primate.: *Spine*: 24: 1179-1185.
15. Boden SD. (2002): Overview of the biology of lumbar spine fusion and principles for selecting a bone graft substitute.: *Spine*.: 27: S26-S31.
16. Bogduk NED. (1999): Nerves of the lumbar spine. In *Clinical Anatomy of The Lumbar Spine And Sacrum*. 3rd ed., Churchill Livingstone: pp 127-144.
17. Bono CM and Lee CK. (2004): Critical analysis of trends in fusion for degenerative disc disease over the past 20 years.: *Spine*. 29: 455-463.
18. Brantigan J, Steffee A, Lewis M (2000): Lumbar interbody fusion using the Brantigan I/F cage for posterior lumbar interbody fusion and the variable pedicle screw placement system: *Spine*: 25: 1437-1446.
19. Buranapanitkit B, Lim A, Geater A: (2001): Misdiagnosis in vertebral osteomyelitis problems and factors. *J Med Assoc Thai* 1984: 1743-1750.
20. Butler J, Shelly M, Timlin M, Powderly W and O'Byrne J: (2006): Nontuberculous pyogenic spinal infection in adults: a 12-year experience from a tertiary referral center: *Spine*: 31: 2695-2700.
21. Casado E, Olive A and Holgado S, (2001): Musculoskeletal manifestations in patients positive for human immunodeficiency virus: correlation with CD4 count, *J Rheumatol* 28:802.
22. Ceroni D, Cherkaoui A, Kaelin A, Schrenzel J: (2010): Kingella kingae spondylodiscitis in young children: toward a new approach for bacteriological investigations? A preliminary report. *J Child Orthop* 4:173-175.
23. Chan KL and Krishnan H (2011): multidrug resistant TB involving the spine, clavicle and ribs. *Malaysian orthopaedic journal*. (5):1:71-74.
24. Chandnani VP, Beltran J and Morris CS (1990): Acute vertebral osteomyelitis and abscess detection with MR imaging versus CT, *Radiology* 174: 233.
25. Chang MC, Wu HT, Lee CH et al (2006): Tuberculous spondylitis and pyogenic spondylitis: comparative magnetic resonance imaging features. *Spine (Phila Pa 1976)*: 31: 782-8.
26. Chen W.H, Jiang L.S and Dai L.Y (2007): Surgical treatment of pyogenic vertebral osteomyelitis with spinal instrumentation *Eur Spine J*:: 16:1307-1316.

27. *Chen WH, Jiang LS, Dai LY (2007):* Surgical treatment of pyogenic vertebral osteomyelitis with spinal instrumentation. *Eur Spine J*; 16: 1307-16.
28. *Colmenero JD, Jimene-Mejias ME and Reguera JM (2005):* Tuberculous vertebral osteomyelitis in the new millennium, still a diagnostic and therapeutic challenge. *Eur J Clin Microbial Infect Dis* 23: 477-483.
29. *Colmenero JD, Ruiz-Mesa JD, Plata A, Bermudez P, Martin-Rico P, et al (2008):* Clinical findings, therapeutic approach, and outcome of bruce liar vertebral osteomyelitis. *Clin Infect Dis*. 1; 46(3):426-33.
30. *Crema MD, Pradel C, Marra MD, et al, (2007):* Intramedullary spinal cord abscess complicating thoracic spondylodiscitis caused by *Bacteroides fragilis*. *Skeletal Radiol* 36:681--683.
31. *Dagermanjian A, Schils J and Mchenry M (1996):* MRI of vertebral osteomyelitis revisited. *Am. J. Roentgenol*; 167: 1539 – 1543.
32. *D'Agostino C, Scorzolini L, Massetti AP, et al, (2010):* a seven year prospective study on spondylodiscitis: epidemiological and microbiological features. *Infection*; 38: 102-107.
33. *Dai LY, Chen WH, Jiang LS (2008):* Anterior instrumentation for the treatment of pyogenic vertebral osteomyelitis of thoracic and lumbar spine. *Eur Spine J*. Jun 25.
34. *Dall BE, Rowe DE, Odette WG, Batts DH (2013):* Postoperative discitis: diagnosis and management. *Clin Orthop Relat Res* (224):138-46.
35. *Darouiche RO: Spinal epidural abscess. N Engl J Med*; 355: 2012-20, 2006.
36. *Dass B, Puet TA and Watanakunakorn C (2002):* Tuberculosis of the spine (Pott's disease) presenting as 'compression fractures'. *Spinal Cord*: 40, 604 -608.
37. *De Letona, J. M. L., Gerstein, N., Rigamonti, D., Metellus, P. and Darouiche, R. O.: Spinal epidural abscess. NEJM* 356: 638-638, (2007): Denis F. The three column spine and its significance in the classification of acute thoracolumbar spinal injuries. *Spine (Phila Pa 1976)*.1983 Nov- Dec.
38. *Dufour V, Feydy A, Rillardon L (2005):* Comparative study of postoperative and spontaneous pyogenic spondylodiscitis.: *Semin Arthritis Rheum*: 2005;34:766 -771.
39. *Edgar G. Dawson, M. D. and Ms. Mary Claire Walsh, (2006):* Arachnoiditis. *Spine Universe Staff Writer*.
40. *Ellis Harold: Clinical anatomy, (2006):* A revision and applied anatomy for clinical students. 11th edition, Blackwell.
41. *Eltahawy AT, Mokhtar AA, Khalaf RM, Bahnassy AA. (1992):* Postoperative wound infection at a University hospital in Jeddah, Saudi Arabia. *J Hasp Infect*; 21: 79-83.
42. *Enam SA, Shah AA, (2006):* treatment of spinal TB; role of surgical intervention. *Pak J Neurol Sci*; 1(3):145-51.
43. *Enoch DA, Cargill JS, Laing R, et al, (2008):* Value of CT- guided biopsy in the diagnosis of septic discitis. *J Clin Pathol* 61: 750-3.
44. *Fayazi AH, Ludwig SC, Dabbah M, Bryan Butler R and Gelb DE (2005):* Preliminary results of staged anterior debridement and reconstruction using titanium mesh cages in the treatment of thoracolumbar vertebral osteomyelitis.: *Spine J*.: 4:388-395.
45. *Fayazi AH, Ludwig SC, Dabbah M, Bryan Butler R and Gelb DE (2005):* Preliminary results of staged anterior debridement and reconstruction using titanium mesh cages in the treatment of thoracolumbar vertebral osteomyelitis.: *Spine J*.: 4:388-395.
46. *Fenollar F, Levy PY, Raoult D, (2008):* Usefulness of broad- range PCR for the diagnosis of osteoarticular infections. *Curr Opin Rheumatol* 20: 463-70.
47. *FORD, L. T. and KEY, J. A. (2011).* *Surg. Forum*, 2: 447.
48. *Fouquet B, Goupille P, Jattiot F, et al (1992)* Discitis after lumbar disc surgery, features of "aseptic" and "septic" forms. *Spine*; 17: 356-8.
49. *Franco-Huerta M, Martinez-Marcos FJ, Borrachero- Garro C, et al, (2009):* Brucellar spondylodiscitis in the emergency department. *Emergencias*; 21: 386-388.
50. *Frank AB, Douglas EG, Jack EZ (2003):* Spinal infections in the immunocompromised host. *Orthop Clin N Am* 27(1 ): 37--46, Jan 1996. quoted from George W. Wood II: *Infections of spine: in Terry C: Sample's operative orthopedics, Tenth edition, Volume 3; 3093-3125.*
51. *Frank L. Acosta JR., M.D., Cynthia T. Chin, M.D., Alfredo Quiones- Hinojosa, M.D., Christopher P. Ames, M.D., Phillip R. Weinstein, M.D., AND Dean Chou, M.D. (2004):* Diagnosis and management of adult pyogenic osteomyelitis of the cervical spine, *Neurosurg Focus* 17 (6): E2.
52. *Frankel HL, Hancock DO, Hyslop G, et al: The value of postural reduction in the initial management of closed injuries of the spine with paraplegia and tetraplegia. I. Paraplegia* 7: 179-192, 1969.
53. *Friedman JA, Maher CO, Quast LM, et al. Spontaneous disc space infections in adults.*

- Surglew DP, Waldvogel FA (2004): Osteomyelitis. Lancet 364:369-79.*
54. *Fukuta S, Miyamoto K, Masuda T, Hosoe H, Kodama H, Nishimoto H., Sakaeda H, Shimizu K. (2003): Two-stage (posterior and anterior) surgical treatment using posterior spinal instrumentation for pyogenic and tuberculous spondylitis. Spine:28: E302-E308.*
  55. *Gasbarrini AL, Bertoldi E, Mazzetti M, Fini L, Terzi S (2005): Clinical features, diagnostic and therapeutic approaches to haematogenous vertebral osteomyelitis. European Review for Medical and Pharmacological Sciences 9: 53-66.*
  56. *George W. Wood H (2003): Infections of spine: in Terry C: Sample's operative orthopedics, Tenth edition, Volume 3; 3093-3125.*
  57. *Geyik MF, Nas K, Evik Eb, Sara J, Dikicic B, Ayaza C (2002): Musculoskeletal involvement in brucellosis in different age groups: a study of 195 cases. Swiss Med Wkly; 132: 9 8-105.*
  58. *Ghaffarpour m, Khoshroo a, Harirchianmh, et al (2007): clinical, epidemiological, laboratory and imaging aspects of brucellosis with and without neurological involvement. Acta Medica Iranica, 45(1 ): 63-68.*
  59. *Gouliouris T, Aliyu SH AND Brown NM, (2010): Spondylodiscitis: update on diagnosis and management. J Antimicrob Chemother 65 Suppl 3: iii11-24.*
  60. *Govender S.: Spinal infections.: [Br] J Bone Joint Surg:2005: 87- B: 1454-1458.*
  61. *Grainger RG and Allison DJ, (2008): Grainger & Allison's Diagnostic Radiology; a textbook of medical imaging; infective disorder of the spine. Elsevier Inc, 5th ed. Ch60.*
  62. *Grammatico L, Baron S, Rusch E, Lepage B, et al (2008): Epidemiology of vertebral osteomyelitis (VO) in France. Epidemiol. Infect. 136: 653-660.*
  63. *Greenberg MS (2010): spine in Jones. Handbook of Neurosurgery, (eds.) Thieme medical publisher, New York, 7th ed., ch.28, pg.947, 2010.*
  64. *Gulati Y, Gupta R (2005): operative treatment of tuberculosis of dorsal and lumbar spine. Apollo medicine, vol. 2, no. 2, June.*
  65. *Hadjipavlou AG, Mader JT, Necessary JT, et al (2000): Hematogenous pyogenic spinal infections and their surgical management. Spine (Phila Pa 1976)25: 1668-79.*
  66. *Hamdan TA (2012): Intra disc space infection after discectomy: A report on thirty-five patients Int Orthop; 36(2): 445-450.*
  67. *Hirose S, Li M, Kojima T, et al (2007): A histological assessment on the distribution of the osteocytic lacunar canalicular system using silver staining. J Bone Miner Metab; 25(6):374 -82.*
  68. *Hong SH, Choi FY, et al (2009): MR Imaging Assessment of the Spine: Infection or an Imitation? Radiographics 29: 599-612.*
  69. *Hsieh MK, Chen LH, Niu CC, Fu TS, Lai PL, and Chen WJ (2011): Postoperative anterior spondylodiscitis after posterior pedicle screw instrumentation. The Spine Journal 11:24-29.*
  70. *Hsien PC, Wienecke RJ, O'Shaughnessy BA, et al., (2004): Surgical strategies for vertebral osteomyelitis and epidural abscess. Neurosurg Focus;1.*
  71. *Huang JJ, Ruaan MK, Lan RR and Wang MC. (2004): Acute pyogenic iliopsoas abscess in Taiwan: clinical features, diagnosis, treatments and outcome. J Infect 2000;40:248-55. quoted from-Hsin-Pei Yin, Yun- An Tsai, Su-Fen Liao, Pei-Hsin Lin, and Tien-Yow Chuang: The Challenge of Diagnosing Psoas Abscess, J Chin Med Assoc;67: 156- 159.*
  72. *Jain AK (2010): tuberculosis of the spine. A fresh look at an old disease. j bone jointsurg [br]. vol. 92-b:7:905-13.*
  73. *Jang JS and Lee SH (2004): Atypical form of multiple spinal tuberculosis. J Korean Neurosurg Soc; 36: 340-341.*
  74. *John M. Rhee and John Gaylard Heller (2003): Spinal infection. The adult and pediatric spine, Fourth edition, Voll: 165-189.*
  75. *John WF, Thomas BB and Timothy LK. (1997): The adult spine, 2nd edition, 871 - 891.*
  76. *Jones AL, Bucholz RW, Bosse MJ (2006): BMP-2 Evaluation in surgery for tibial trauma allograft (BEST-ALL) study group. Recombinant human BMP-2 and allograft compared with autogenous bone graft for reconstruction of tibial diaphyseal fractures with cortical defects. A randomized controlled trial.: JBJS Am: 88 (7): 1431-41.*
  77. *Karadimas EJ, Bunker C, Lindblad BE et al spondylodiscitis. A retrospective study of 163 patients. Acta Orthop; 79: 650-659, (2008): Karadimas of 163 patients. Acta Orthop; 79: 650-659, 2008.*
  78. *Kenneth Todar (2005): Staphylococcus, University of Wisconsin-Madison Department of Bacteriology. SCIENCE Magazine VOL 304 04 June, 2004. quoted from Todar's Online Textbook of Bacteriology.*
  79. *Kenyon PC, Chapman AL (2009): Tuberculous vertebral osteomyelitis: findings of a 10-year review of experience in a UK centre. J Infect 59: 372-3.*
  80. *Khan SH, Hussain MS, Griebel RW and Hattingh S. (2003): Comparison of primary and secondary spinal epidural abscesses: a*

- retrospective analysis of 29 cases. *Surg Neurol*;59:28-33.
81. Kim CJ, Song KH, Jeon JH et al (2010): A comparative study of pyogenic and tuberculous spondylodiscitis. *Spine*;35: 1096-1100.
  82. Kotil K, Alan MS, Bilge T (2007): Medical management of Pott disease in the thoracic and lumbar spine: a prospective clinical study. *J Neurosurg Spine* 6:222-228..
  83. Kotze and Erasmus (2006): MRI findings in proven mycobacterium tuberculosis (tb) spondylitis. *SA journal of radiology* (June) 6-12.
  84. Kowal ski TJ, Berbari EF, Huddleston PM, et al (2006): Do follow-up imaging examinations provide useful prognostic information in patients with spine infection? *Clin Infect Dis* 43: 172-9,.
  85. Kulkarni AG, Hee HT (2006): Adjacent level discitis after anterior cervical discectomy and fusion (ACDF): a case report. *Eur Spine J* 15 (Suppl. 5): S559-S563.
  86. Lecouvet F, Ireng L, Vandercam B, et al, (2004): The etiologic diagnosis of infectious discitis IS improved by amplification -based DNA analysis. *Arthritis Rheum* 50: 2985-94.
  87. Ledermann HP, Schweitzer ME, Morrison WB et al, (2003): MR imaging findings in spinal infections: rules or myths? *Radiology* 228: 506-14.
  88. Legrand E, Flipo RM, Guggenbuhl P et al, (2001): Management of nontuberculous infectious discitis. Treatments used in 110 patients admitted to 12 teaching hospitals in France. *Joint Bone Spine*; 68: 504-9.
  89. Lillie P, Thaker H, Moss P, et al, (2008): Healthcare associated discitis in the era of antimicrobial resistance. *Clin Rheumatol* 14: 234-7.
  90. Liu WH, Hsieh CT, Chan HB, Chiang YH, Su YH, (2006): Salmonella Spondylitis in the Thoracic Spine. *J Med Sci*; 26(6): 223-226.
  91. Luzzati R, Giacomazzi D, Danzi MC, Tacconi L, Concia E, Vento S. (2009): Diagnosis, management and outcome of clinically-suspected spinal infection. *J Infect* 58:259-65.
  92. Mark S G, (2001): Infections. *Hand book of Neurosurgery*, 5th edition: 239-253.
  93. Marvin R. Leventhal (2003): Spinal anatomy and surgical approaches: in Terry C Sample's operative orthopedics, Tenth edition, Volume 3; 2681-2704.
  94. Maslen DR, Jones SR and Crislip MA (1993): Spinal epidural abscess: Optimizing patient care. *Arch Intern Med* 153: 1713.
  95. McEwan L, Wong JC, (2000): Nuclear medicine imaging in early vertebral osteomyelitis: still of clinical utility. *Australas Radiol*44: 454-457.
  96. McHenry MC, Easley KA, Locker GA, (2002): Vertebral osteomyelitis: long-term outcome for 253 patients from 7 Cleveland-area hospitals. *Clin Infect Dis* 34: 1342- 50.
  97. Mesfin FB, Tobin E, Adamo MA, Dirisio D, (2008): Fungal vertebral osteomyelitis due to *Scedosporium apiospermum* after near-drowning. *J Neurosurg Spine* 9:58-61.
  98. Michel SC, Pfirrmann CW, Boos N, et al, (2005): CT-guided core biopsy of subchondral bone and intervertebral space in suspected spondylodiscitis. *AJR Am J Roentgenol* 186: 977-80, 2006 - 1976) 30: 318-23.
  99. Mohamed Nabil Y M Riyad, Mohamed Alaa Sallam and Ali Nur (2003): Pyogenic Psoas Abscess: Discussion of its Epidemiology, Etiology, Bacteriology, Diagnosis, Treatment and Prognosis - Case Report. *Kuwait Medical Journal*, 35 (1): 44-47.
  100. Moorthy S, Prabhu NK, (2002): Spectrum of MR imaging findings in spinal tuberculosis. *AJR Am J Roentgenol*; 179:979-983.
  101. Muangchan C and Nilganuwong S, (2009): The Study of Clinical Manifestation of Osteoarticular Tuberculosis in Siriraj Hospital, Thailand. *J Med Assoc Thai* Vol. 92 Suppl. 2, 101-109.
  102. Muckley T, Schutz T, Schmidt MH, Potulski M, Buhren V and Mylona E, Samarkos M, Kakalou E, (2009). Pyogenic vertebral osteomyelitis: a systemic review of clinical characteristics, *Semin Arthritis Rheum*; 39: 10-7.
  103. Nadeema M, Nadeem S, Mahmood KT (2010): Drug Therapy in Osteomyelitis. *International Journal of Pharmaceutical Sciences*, Vol.2 (2), 67-75,.
  104. Nolla JM, Ariza J, Gomez-Vaquero C et al, (2002): spontaneous pyogenic vertebral osteomyelitis in nondrug users. *Semin Arthritis Rheum*; 3: 271-278.
  105. Olsen MA, Nepple JJ, Riew D, Lenke LG, Bridwell KH, ET AL (2008): Risk Factors for Surgical Site Infection Following Orthopaedic Spinal Operations. *J Bone Joint Surg Am.*: 90:62-9.
  106. One B; Oksiizoglu B; Hatipoglu HG; One<; K; Azak A; Zengin N. (2007): "Cavernous sinus syndrome caused by metastatic colon carcinoma". *Clinical Colorectal Cancer* 6 (8): 593-6. doi:10.3816/CCC.20 07.n.028.; PMID 17681 107.
  107. Osti OL, Fraser RD, Vernon-Roberts B (2014): Discitis after discography: the role of prophylactic antibiotics. *J Bone Joint Surg Br* 72:271-4.
  108. Owolabi LF, Nagoda MM, Amaila AA, Aliyu I, (2010): Spinal tuberculosis in adults: A study of

- 87 cases in Northwestern Nigeria. *Neurology Asia*; 15(3): 239 -244.
109. Pappas G, Akritidis N, Bosilkovski M, et al: *Brucellosis*, (2005): *N Engl J Med* 352: 2325-36.
  110. Parkinson JF, Sekhon LH, (2004 ): Spinal epidural abscess: appearance on magnetic resonance imaging as a guide to surgical management. *Neurosurg Focus* 2004;17: E12. quoted from Rabih O. Darouiche, M. D.: Review article, Spinal Epidural Abscess. *JWatch Neurology* 355:2012-20.
  111. Pau I AG, Serena SH (1996): Pediatric spinal infections. *Orthop Clin N Am* 27( 1): Ill - 123, Jan.
  112. Perlmutterdooley, d. M. And auld, a. W. (1998:) *J. Fla med. Ass*, 57: 25. THIBODEAU.. A. (2002). *J. Bone Jt Surg.*, 50~: 400. FORD, L. T. and KEY, J. A. (2011). *Surg. Forum*, 2: 447.
  113. Perez-Cruet M, Foley K and Isaacs R, (2002): Microendoscopic lumbar discectomy: Technical note.: *Neurosurgery*: 5 1(5 Suppl): S129-S136.
  114. Pigrau C, Almirante B, Flores X, et al, (2005): Spontaneous pyogenic vertebral osteomyelitis and endocarditis: incidence, risk factors, and outcome. *Am J Med* 118: 1287.
  115. Plasschaert H, De Geeter K, Fabry G, (2004): Juvenile spondylodiscitis: the value of magnetic resonance imaging A report of two cases. *Acta Orthop. Belg.*, 70, 627-631.
  116. Po-Liang Lai, MD; Hsieh-Shong Leul, MD MSc; Chi-Chien Niu, MD; Wen- Jer Chen, MD and Lih-Huei Chen, MD (2005): Pyogenic Spondylitis Presenting with Skip Lesions, *Chang Gung Med J* Vol. 28 No. 9, September 2005.
  117. Pradhan BB, Bae HW and Dawson EG (2006): Graft resorption with the use of bone morphogenetic protein: lessons from anterior lumbar interbody fusion using femoral ring allografts and rh BMP-2.: *Spine*: 3 1(10): E277-84.
  118. Przybylski GJ, Sharan AD (2001): Single-stage autogenous bone grafting and internal fixation in the surgical management of pyogenic discitis and vertebral osteomyelitis. *J Neurosurg* 94:1-7. 30.
  119. Quinones-Hinojosa a, Jun P, Jacobs R, Rosenberg WS, Weinstein PR, (2004): General principles in the medical and surgical management of spinal infections: a multidisciplinary approach. *Neurosurg Focus* 17 (6): E 1, 1••17.
  120. Rabih. Darouiche, M. D., (2007): Review article, Spinal Epidural Abscess. *JWatch Neurology* 355:2012 -20.
  121. Raffo C, Wiesel S and Lauerman W. (2003): Determining reasons for tailed lumbar spine surgery. In *The Adult Spine*. Philadelphia: Lippincott-Phila Raven:945-954.
  122. Rahme R, Moussa R, (2008): The Modic Vertebral Endplate and Marrow Changes: Pathologic Significance and Relation to Low Back pain and Segmental Instability of the Lumbar Spine. *AJNR* 29: 838-842.
  123. Rayes M, Colen CB, Bahgat DA, et al; (2010): Safety of instrumentation in patients with spinal infection. *J Neurosurg Spine* 12:647-59.
  124. Rayner CR, Baddour LM, Birmingham MC et al, (2004): Linezolid in the treatment of osteomyelitis: results of compassionate use experience. *Int J Infect Dis*; 32: 8-14.
  125. Reihnsaus E, Waldbaur H, Seeling W, (2004): Spinal epidural abscess: a meta-analysis of 915 patients. *Neurosurg Rev* 23:175-205.
  126. Rhoton AL Jr, Xiaoguang Tong, Pablo Rubino, Hiroshi Abe, Chanyoung Choi, (2002); 12:63-104.
  127. Richard MO, Rick BD (1996): Pyogenic vertebral osteomyelitis and post surgical disc space infections. *Orthop Clin N Am* 27(1): 87 - 94, Jan 1996. Robert JM, Hansen AY: Neurosurgical care of spinal epidural, subdural, and intramedullary abscesses and arachnoiditis. *Orthop Clin N Am* 27(1): 125 -136, Jan 1996.
  128. Roberts FJ, Walsh A, Wing P (1998): The influence of surveillance methods on surgical wound infection rates in a tertiary care spinal surgery service. *Spine*; 23: 366-70.
  129. Robert JM, Hansen AY (1996): Neurosurgical care of spinal epidural, subdural, and intramedullary abscesses and arachnoiditis. *Orthop Clin N Am* 27( 1): 125 - 136, Jan 1996.
  130. Rocco RC and John ML (2003): Overview and classification of spinal infections. *Orthop Clin N Am* 27(1): 1 - 8, Jan 1996. quoted from John W, Frymoyer, M.D., M.S, Sam W. Wiesel, M.D., Howard S. An, M.D., William C. Laurman, M.D., Scott D., M.D., Lawrence G., M.D. and Robert F., M.D.: Spinal infections. The adult and pediatric spine, Forth edition, Volume 2; 10; 156-189.
  131. S. A. Pilkington, S. A. Jackson and G. R. Gillett (2003): Spinal epidural abscess. *British Journal of Neurosurgery*, Volume 17, Issue 2, pages 196 - 200, April 2003.
  132. Sandhu H, Kanim L and Toth J. (2007): Experimental spinal fusions with recombinant human bone morphogenetic protein-2 without decortication of osseous elements: *Spine*::22: 1171-1176.
  133. Sapico FL, Montgomerie JZ (2007): Pyogenic vertebral osteomyelitis. Report of nine cases and review of literature. *Rev Infect Dis* 1: 754-776,.

- quoted from Marisol Fernandez, Clark L. Carrol and Carol J. Baker.
134. *Sebastiani GD, Galas F, (2001):* Spondylodiscitis due to *Candida tropicalis* as a Cause of Inflammatory Back Pain. *Clin Rheumatol* 20: 435--437.
  135. *Shumy F, Anam AM, Chowdhury MA, Azad AK, Nahar S, (2011):* Multifocal Extensive Spinal Tuberculosis with Retro-pharyngeal Abscess. *BSMMU J*: 4(2): 128-130.
  136. *Silber JS, Anderson DG, Vaccaro AR, et al., (2002):* Management of postpro-cedural discitis. *Spine J*. Jul- Aug;2(4):279-87.
  137. *Sinnatamby CS Ed. ( 2006):* Last's Anatomy. In Regional and Applied. 11th ed., Churchill Livingstone: pp 438-456.
  138. *Slucky AV (2001):* Spinal infection, *Clinical orthopedics*, Lippincott Williams and Wilkins, 419-426.
  139. *Snell RS, (2010):* clinical neuroanatomy. 7 the dition, Lippincott Williams & Wilkins.
  140. *Soames RW, Williams PL, Bannister LH, Berry MM, Collins P, Dyson M, Dussek JE and Ferguson MWJ Bogduk Ned (2010):* Nerves of the lumbar.
  141. *Stabler A and Reiser MF, Imaging of spinal infection: Radiologic clinics of North America: Volume 39 (2001):* Number 1, Jan; 115:139.
  142. *Standring S, (2005):* back and macroscopic anatomy. *Gray's Anatomy*, 39th edition, Elsevier Ltd.
  143. *Tandon N, Vollmer DG, (2004):* Infections of the spine and spinal cord, Winn HR (ed): *Youmans Neuro logical Surgery*, ed 5. Philadelphia: Saunders, Vol 4, pp 4363- 94.
  144. *Tasdemiroglu E, Sengoz A, Bagatur E, (2004):* Iatrogenic spondylo- discitis. *Neurosurg Focus* 16 (6): Clinical Pearl 1, 1-6.
  145. *Taylor JR and Towney LT: The development of the human intervertebral disc. In The Biology of the intervertebral disc, Ghosh (ed), p. 39-80, 1988. Thalgott JS, Giuffre JM and Fritts K (2001):* Instrumented posterolateral fusion using coralline hydroxyapatite with or without demineralized bone matrix.: *Spine* 1.: 1:131-137.
  146. *Thalgott JS, Giuffre JM and Fritts K (2001):* Instrumented posterolateral fusion using coralline hydroxyapatite with or without demineralized bone matrix.: *Spine* 1.: 1:131-137.
  147. *Tins BJ, Cassar-Pullicino VN and Lalam RK. (2007):* Magnetic resonance imaging of spinal infection.: *Top Magn Reson Imaging* 18:213-222.
  148. *Tins BJ, Cassar-Pullicino VN, (2004):* MR Imaging of Spinal Infection. *Seminars in Musculoskeletal Radiology* 8:215-229.
  149. *Torda AJ, Gottlieb T, Bradbury R (1995)* Pyogenic vertebral osteomyelitis: analysis of 20 cases and review *Clin Infect Dis*; 20: 320-8.
  150. *Uchida K, Nakajima H, Yayama T, Sato R, Kobayashi S, Chen KP, (2010):* Epidural abscess associated with pyogenic spondylodiscitis of the lumbar spine; evaluation of a new MRI staging classification and imaging findings as indicators of surgical management: a retrospective study of 37 patients. *Arch Orthop Trauma Surg*: 130:111-118.
  151. *Weinstein MA, McCabe JP and Cammisa FP Jr (2003):* Postoperative spinal wound infection: a review of 2391 consecutive index procedures, *J Spinal Disord* 13:422.
  152. *Wesley W. Parke, Ph.D.; (2001):* Applied anatomy of the spine. The spine, Forth edition, Volume 135-50.
  153. *Williams PL and Warwick R (2003):* Gray's Anatomy, 6th Edition, Churchill Livingstone, Edinburgh London, Melbourne and New York, PP: 113-139.
  154. *Wirtz DC, Genius I, Wildberger JE, Adam G, Zilkens KW, Niethard FU. (2000):* Diagnostic and therapeutic management of lumbar and thoracic spondylodiscitis: an evaluation of 59 cases. *Arch Orthop Trauma Surg* 120:245-51.
  155. *Woertgen C, Rothoerl RD, Englert C, et al, (2006):* Pyogenic spinal infections and outcome according to the 36-item short form health survey. *J Neurosurg Spine*; 4: 441-6. [www.medscape.com](http://www.medscape.com) (online): *Neurosurg focus* 17(6), 2004. [www. Na.ox.ac.uk /wfsa/html /u13/u13111D1.htm](http://www.Na.ox.ac.uk/~wfsa/html/u13/u13111D1.htm) - 8-11- 2012.
  156. *Zeller V, Desplaces N, (2006):* Antibiotherapy of bone and joint infections. *Rev Rhum*; 73: 183-90.
  157. *Zimmerli W, (2010):* Vertebral osteomyelitis. *N Engl J Med*; 362:1022- 1029.

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