Spine Postoperative Infections: Risk Factors

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Introduction

Postoperative spinal wound infections have been reported in 0.7-12% of the surgical cases. It can be a deleterious complication, resulting in increased morbidity, mortality and health care costs. The rate of surgical site infections is different according to the type of spinal surgery. It has been reported that, laminectomy has a lower risk than fusion with instrumentation, a posterior approach has a higher risk than an anterior approach and, surgery of spinal metastasis is associated with more infections than surgery for degenerative disease. A wide variety of risk factors have been described in previous series.
In this review, six published papers concerning risk factors for postoperative spine infections are reviewed and analyzed. The first three papers analyzed the classic risk factors usually described in the literature and, the other three papers focused on, diabetes and perioperative glucose management, the post-irradiated surgical field and the inspired fraction of oxygen during surgery. Because of the high frequency of spinal surgeries and the high morbidity associated with postoperative infections, understanding the risks factors of surgical site infections is an important issue to be considered for future researches and protocols.

1) "POSTOPERATIVE WOUND INFECTIONS OF THE SPINE"

Neurosurg Focus 15 (3) 2003; 14: 1-5

Information

In this study the authors reviewed the incidence, risk factors, prophylactic antibiotic regimens, treatment and outcomes associated with postoperative lumbar infections.

The authors showed that the type of surgery was the most significant variable that affected the rate of infection: <1% for a simple lumbar discectomy, 1.5-2% for extensive decompressions without fusion and, 3-6% with the addition of fusion.

Other factors were malnutrition, extended pre-hospitalization, high blood loss (> 1000 ml), and prolonged operative time (>3 hours). Age alone was not described as an important predictor of postoperative wound infections.

The authors also analyzed the importance of wound evaluation for the diagnosis of postoperative infection, with no pathognomonic symptoms or signs.
Laboratory studies as C-reactive protein (CRP) and erythrocyte sedimentation rate (ESR) were considered sensitive but not specific. There was no optimal imaging modality that could detect a postoperative wound infection.

In this study the authors recommended a first-generation cephalosporin for antibiotic prophylaxis, which had to be administered before performing the skin incision. They also recommended aggressive surgical treatment of postoperative wound infections, with removal of all necrotic tissue and foreign materials. Consolidating bone graft and instrumentation should not be removed unless the infection is not clearing with repeated debridement. Deep infections were treated with a 6-week course of intravenous antibiotic agents.

Analysis

Several risk factors for postoperative spinal wound infections have been analyzed and described by the authors. The most significant factor associated with wound infections was the type of surgery. Wound appearance, drainage and patient´s clinical symptoms, were the most important keys to diagnose a postoperative surgical site infection. Laboratory studies were not specific and there was no optimal imaging modality that could detect postoperative wound infections.

The authors' recommendations about preoperative antibiotic prophylaxis and surgical management of postoperative wound infections were in accordance with previously published studies.

2) "RISK FACTORS FOR SURGICAL INFECTION IN SPINAL SURGERY"

Journal of Neurosurgery (Spine 2) 2003; 98: 149-155

Information

Surgical site infections (SSI) result in increased rates of morbidity, mortality and length of hospital stay and costs. Multiple publications have identified several risk factors associated with SSI, as older age, diabetes, obesity, smoking, bowel/bladder incontinence, previous spinal surgery, placement of instrumentation, multilevel surgery, fusion extending to the sacrum, preoperative/perioperative steroids and intraoperative blood loss. Most of the previous publications were descriptive and lacked statistical power.

The authors present a retrospective case-control study of risk factors associated with spinal surgery during a four year period at a single institution. Patients undergoing laminectomy, fusion or laminectomy and fusion performed by a neurosurgeon, were examined. Of the 1918 spinal surgeries performed, a total of 53 (2.76%) SSI were identified. They used the Center for Disease Control and Prevention/National Nosocomial Infection Surveillance definition of deep (25), organ space (9) and superficial (7) SSI. Of these, 12 were excluded because of missing records or the presence of a preexisting SSI, leaving 41 cases for the analysis. A total of 179 control patients were randomly selected.

Cultures were obtained in 39 of the 41 patients and the most common organism isolated was Staphylococcus Aureus, 15/39 (38%). In 17/39 (44%) cases they found Gram negative rods and/or anaerobes. This was more significant in patients undergoing lumbar surgery (15/24), compared to thoracic and cervical spine surgery (2/15).

From the univariate analysis, the greatest risk factor for SSI was postoperative incontinence (OR 8.8). However, preoperative incontinence was also significantly associated with a higher risk of infection (OR 3.4). Other factors included were: ASA class, surgery involving more than two intervertebral spaces, tumor resection, incontinence, PRBC transfusion, BMI >35, serum glucose >200 mg/dl, posterior approach and the use of an operating microscope.

Compared to uninfected controls, there was a longer preoperative length of hospital stay and duration of surgery, more intervertebral levels, longer stay in the ICU, and a longer overall postoperative hospitalization. The significance of the use of an operating microscope appears to be a reflection of the approach, as it was used in 75 % of the anterior procedures versus only 30% of the posterior procedures. Factors which were not associated with increased risk of infection include: fusion, instrumentation, smoking, timing of prophylactic antibiotic administration, surgery for injury or trauma, intraoperative hypothermia, spinal cord or nerve root compression, history of diabetes, and previous spinal surgery. Although a serum glucose level >200 mg/dl was associated with an increased risk of SSI, only 41% of those patients had a previous diagnosis of diabetes.

Multivariate analysis showed that postoperative incontinence (OR 8.2), posterior approach (8.2), tumor resection (6.2), and BMI>35 (5.2) were all independently associated with an increased risk of SSI. The model had a classification accuracy of 84%, with 89 % of uninfected patients and 63% of infected patients correctly classified.

Analysis

The two most influential risk factors associated with SSI were posterior approach and postoperative incontinence. Almost in 50% of cultures grew Gram negative rods or anaerobes suggesting contamination with fecal or urinary flora. Indwelling urinary catheters were in place in the majority of patients with postoperative incontinence. As result, the most likely source of infection was fecal contamination of posterior wounds in incontinent patients. From a prevention standpoint, the use of leak proof diapers and occlusive dressing may decrease the contamination of posterior wounds.

A BMI >35 was also found to be an independent risk factor. In the univariate analysis there was a general trend toward an increased risk with increasing BMI. However, the only category which reached significance was a BMI>35.

This may be due to an association with a glucose level >200 mg/dl which occurred in 52% of morbidly obese patients. Analysis of this association is limited by the absence of perioperative glucose testing in 47 patients. Patients with an elevated BMI should receive careful weight based dosing of prophylactic

antibiotics as well as tight glucose control with insulin pumps/drips to maintain a glucose level<200 mg/dl.
Another independent risk factor was surgery for tumor resection which may be associated with increased duration of surgery. Interestingly length of surgery was found to be significant in the univariate analysis but lost significance after controlling for tumor resection. In long procedures there should be re-dosing of prophylactic antibiotics to maintain therapeutic levels.

The authors found that spinal instrumentation and fusion were not associated with an increased risk of infection, which they relate to their use of prophylactic antibiotics and intraoperative bacitracin irrigation.

Multiple publications have found an association between infection and smoking, which was contrary to authors' findings. They suggested that this was the result of multiple statistical testing. There was no increased risk found with older age or previous spinal surgery as has been previously reported. This was thought to be secondary to the small number of cases and the inclusion of multiple types of surgery in previous studies.

Overall the authors presented a large multivariate analysis which has identified independent risk factors for SSI with a predictive ability greater than 80%. Prevention of the risk associated with these factors is of extreme importance as the authors also demonstrated an increased morbidity, length of stay, and necessity for repeated surgical interventions associated with SSI.

3) "INCIDENCE, PREVALENCE, AND ANALYSIS OF RISK FACTORS FOR SURGICAL SITE INFECTION FOLLOWING ADULT SPINAL SURGERY"

Spine Volume (34) 2009; 13: 1422–1428

Information

Surgical site infections (SSI) after adult spinal surgery have been reported to occur in 0.7% to 12.0% of the patients resulting in higher postoperative morbidity, mortality, and health care costs. A variety of risk factors have been identified by several authors. Patients age, obesity, diabetes, urinary incontinence, tobacco use, poor nutritional status, complete neurologic deficit, revision surgery, non-steroidal anti-inflammatory drugs, posterior surgical approach, tumor resection, increased estimated blood loss (EBL), blood transfusion, prolonged surgical time, multilevel surgery fusions extending to the sacrum, spinal instrumentation and, the presence of more than 3 comorbid diseases have all been linked to an increased risk of SSI in adult spinal surgery. However, most of these studies were limited by a small sample size and failed to include potential confounding risk factors, making their findings difficult to interpret.

The authors have performed a retrospective cohort analysis of 3174 adult patients undergoing all types of spinal surgery in a period of nearly 10 years. They found an overall clinical SSI rate of 4.2%, with subgroups demonstrating rates ranging from 1.4% to 10.3%.

In their analysis, they identified more than 10 risk factors that seemed to influence the risk of SSI in univariate analysis. With subsequent multivariate analysis, the authors were able to identify 3 independent factors that increased patients' risk: EBL greater than 1 liter, history of diabetes and history of SSI. However, surgery done by the anterior approach had a lesser risk. Patients diagnosed with inflammatory arthritis had the highest risk of SSI and obesity was the only independent risk factor that increased the rate of superficial wound infections.

Analysis

In this patient population, the overall rate of clinically significant SSI, following adult spinal surgery, was 4.2%. The authors were able to investigate multiple potential confounding variables and determine the absolute risk for different patient subgroups.

The increased SSI risk with EBL of more than 1 liter was consistent with previous authors who studied spinal trauma patients and elective spinal surgeries. This finding was also consistent with several studies in the field of cardiovascular surgery. Therefore, one should attempt to minimize EBL in any surgical procedure and minimize need for nonautologous blood transfusions.

The history of a prior SSI significantly increased the risk of another SSI during the current surgery. This was a finding that has been reported before. Although a patient may not have any signs, symptoms, or laboratory findings consistent with an active wound infection, individual bacteria can remain encapsulated in the scarred tissue and lie dormant until a new surgery releases them.

Diabetes mellitus was found to be an independent risk factor for SSI, which is consistent with multiple prior studies. Diabetes impairs wound healing because microangiopathic changes lead to local tissue ischemia and lower tissue concentrations of administrated antibiotics. In addition, granulocyte function is impaired in diabetic patients leading to a relative immune suppression and impaired platelet-derived growth factor function can further jeopardize wound healing. Tight regulation of blood sugar perioperatively was described to decrease the risk of SSI.

In this study, the risk of SSI was directly related to the surgical approach used. Isolated anterior surgical approaches were associated with a 1.7% risk of SSI while any surgery that included a posterior spinal approach was associated with a minimum of a 4.4% risk of infection. This finding is consistent with the results of Levi et al. who did not find SSI after anterior spinal surgery.

When superficial SSI were analyzed, an anterior surgical approach was found to decrease their risk, while obesity was found to be the only independent risk factor that increased them. When the SSI deep to the fascia were investigated, they found that comorbid diabetes, and prior SSI were independent risk factors for deep SSI. Similar to superficial infections, obesity was also found to increase the risk of deep SSI. Finally, longer surgical procedures were found to have a higher risk for deep SSI (operative time: 2–5 hours, OR=2.4; >5 hours, OR=2.9). Longer operative times result in increased periods of tissue retraction

with production of tissue ischemia, necrosis, and desiccation. These can increase the risk of wound contamination.
Overall the authors present a retrospective cohort analysis of 3174 patients, which has identified independent risk factors for SSI and the absolute risk of SSI for different patient subgroups.

4) "DIABETES ASSOCIATED WITH INCREASED SURGICAL SITE INFECTIONS IN SPINAL ARTHRODESIS"

Clin Orthop Relat Res (2009) 467:1670-1673

Information

The medical records of 244 patients with elective lumbar posterior arthrodesis were reviewed from January 1, 2003 until March 31, 2008. From this group, 33 patients were excluded due to: a history of previous spinal surgery or spinal infections, age younger than 18 or older than 90 years old, having received a different antibiotic prophylaxis other than cefazolin, or a follow-up shorter than 12 months. The selection criteria left 195 patients, 165 were non diabetics and 30 were diabetics. The infection diagnosis criteria included deep surgical site or organ space infection within 30 days after surgery (or within 1 year with implant placements) or superficial surgical site infections within 30 days after surgery. The data collected included age, gender, body mass index, surgical time, ASA, estimated blood loss, antibiotic redosing given, bone allograft use, drain placement, tobacco use and diabetes mellitus (DM) history. Nine of the 30 diabetic patients developed deep infections and eighteen of the 165 non diabetic patients developed infections. Of these, 17 were deep and only one was superficial. In the univariate analysis, DM incurred a relative risk (RR) of 3.271 (CI 1.457-7.344) and was the most significant risk factor for surgical site infections in patients with posterior spinal instrumentation.

The estimated blood loss was found to be a significant risk factor with a RR 1.608 (CI 1.083-2.390). None of the other factors were associated with a significant increased risk of infection.

A multivariate model was obtained to determine potential confounding factors. The basic model included DM and potential confounding factors were individually added and analyzed. Any variable that produced more than a 10% change in the RR associated with DM was included in the final model. ASA≥3 was the only factor retained in the final model. The adjusted RR of DM patients for developing surgical site infections was 4.1.

Analysis

The authors sought to determine the risk of surgical site infection associated with DM. Previously established significant risk factors such as approach, instrumentation, previous spinal surgery, and extreme age, were controlled during the selection process. Only patients undergoing posterior procedures with instrumentation, no previous history of spinal surgery, and age >18 and <90, were included. When choosing to examine the high risk group of patients with

posterior spinal instrumentation, the authors attempted to increase the incidence and therefore statistical significance of their findings.
The authors also selected patients from a single surgeon series to minimize the effect of differences in surgical technique. In addition to the previously mentioned limitations, the study has an average follow up of 30 months (range 12-60) which allows for the possibility of missing rare late infections. However, the present study clearly demonstrates that a history of DM is an independent risk factor for surgical site infections. Estimated blood loss was the only other factor which demonstrated an increased risk for infection in the univariate analysis. However, its effects were not significant in the multivariate analysis. The only factor which significantly affected the multivariate model was ASA≥3. Other factors ,which have been shown in larger studies to be associated with an increased risk of surgical site infection, did not reach statistical significance in either the univariate or multivariate analysis. This may be secondary to the small numbers, designs and limitations of the studies.

5) "SURGICAL SITE INFECTION IN SPINAL METASTASIS. RISK FACTORS AND COUNTERMEASURES"

Spine Vol (34) 2009; 6: 635-639

Information

The goal of surgical treatment for spinal metastasis is to maintain quality of the remaining life. Most patients with spinal metastasis suffer from poor nutritional status, immunosupression, as well as previously irradiated tissue. Multiple publications have demonstrated that patients undergoing surgery for spinal metastasis are at an increased risk for surgical site infection. A recent publication demonstrated the utility of prostaglandin E1 (PGE1) in decreasing SSI after laryngeal surgery in patients that were previously irradiated. This study examined independent risk factors for SSI as well as evaluated the effects of PGE1 in decreasing the risk of SSI in patients with spinal metastasis.

Phase I

The authors first presented a retrospective review of 110 patients undergoing 113 surgeries between 1993 and 2003. Using Tomita prognostic scores, patient underwent en bloc spondylectomy (38), debulking surgery (43), or palliative surgery with decompression and fusion (29). All patients received preoperative antibiotics, cephem in 94 patients, penicillin in 8 patients, and other antibiotics in 11 patients. A total of 8 (7.1%) SSI's occurred during the study period. The most common organism cultured was a coagulase-negative Staphylococcus. All the infections were classified as deep.

A univariate analysis was performed which found that the presence of diabetes (OR 17.7; 95% IC; 3.64-43.6), prior irradiation (OR 41.0; 95% IC; 4.82-63.6), and multiple operations (OR 1.85; 95% IC; 1.11-3.05), were associated with an increased risk of SSI. All of the diabetics (14) in this study were Type I. Prior irradiation occurred in 22 patients with 7 experiencing infection. A history of multiple operations at the same spinal site occurred in 27 patients with 5

developing SSI. Factors that were not found to be significant with the univariate analysis include: age >56, gender, malnutrition, steroid therapy, neurology deficit, extent of surgical resection, emergency resection, operative time, and intraoperative blood loss.

Treatment with chemotherapy and ASA class >3 were not statistically significant but had a p <0.2 and were included in the multivariate analysis. The 3 statistically significant factors as well as chemotherapy and ASA were included in the multivariate analysis. Only a history of diabetes (OR 17.1) and prior irradiation (19.5) were found to be independent risk factors for SSI.

Phase II

The authors also presented a prospective series of 94 patients (97 surgeries) undergoing surgery for spinal metastasis between 2003 -2007. All patients were treated with postoperative PGE1 therapy for a mean duration of 7 days. Based on prognostic factors, patients underwent a wide en bloc resection (50), debulking surgery (27), or palliative decompression (17). A total of 3 (3.1%) SSI, all of which were deep, occurred in irradiated patients treated with PGE1. There were 2 cases of methicillin resistant Staphylococcus Aureus and 1 case of Enterococcus faecalis. There was no difference in age, gender, operative time, blood loss, dose of radiation, or the interval between radiation and operation in the irradiated patients from phase I and phase II. However, the rate of SSI for irradiated patients treated with PGE1 was significantly less (1/22 cases) than the rate for irradiated patients that did not have PGE1 therapy (7/22 cases).

Analysis

The only two factors which the authors found to be independent risk factors for SSI in patients with spinal metastasis were diabetes and previous radiation. An association between SSI and diabetes or serum glucose level has been demonstrated in multiple previous publications. This may be prevented by perioperative serum glucose control with insulin infusion pump to maintain glucose <200 mg/dl. Irradiation was associated with the highest risk of SSI. Tissues which have been previously irradiated have a decreased vascularity, increased fibrosis, hypoxia, impairment of proliferative capacities, resulting in poor wound healing. Treatment with PGE1 was found to significantly decrease the rate of SSI in previously irradiated patients.

As a strong vasodilator, PGE1 increases peripheral blood flow which may reverse some of the negative effects of irradiation. The side effects of PGE1 include pain at the injection site, headache, mild hypotension, and hemorrhagic tendency. In the present study, there were only three cases of pain at the injection site, and treatment was otherwise well tolerated. The major limitation of both phases of this study was the small number of cases which severely limits any statistical conclusions. In phase I, there were only 8 cases of SSI from which an analysis was performed. Diabetes was found to be an independent risk factor but was only present in 9 patients without SSI and in 5 patients with SSI. Similarly prior irradiation occurred in only 15 patients without SSI and in 7 patients with SSI. The caveats of a small number of cases were that many of the factors, which larger studies have found to be associated with increased risk of SSI, determined to be insignificant.

In phase II, the authors compared 22 irradiated patients with 22 irradiated patients that were treated postoperatively with PGE1. There were only 3 cases of infection in phase two. There was only 1 case of SSI in the 22 irradiated patients. Although there was a statistically different rate of infection in the two groups, its significance is limited by the small numbers compared. Further evaluation with a larger group of patients is warranted as the positive effects of PGE1 were promising in preventing the significant morbidity associated with SSI.

6) "INTRAOPERATIVE FRACTION OF INSPIRED OXYGEN IS A MODIFIABLE RISK FACTOR FOR SURGICAL SITE INFECTION AFTER SPINAL SURGERY"

Anesthesiology 2009; 110: 556-562

Information

Surgical site infection (SSI) is related to increased morbidity, mortality, length of stay and overall healthcare costs. Multiple modifiable factors such as fraction of administered oxygen, glucose control, and maintenance of normothermia are associated with an increased of SSI. The purpose of this study was to examine whether these modifiable risk factors were associated with SSI in spinal surgery.
The authors presented a retrospective case control study of patients undergoing laminectomy, spinal fusion, or both from 2001 to 2004. Cases were defined as superficial, deep or organ space based on the Center for Disease Control/National Healthcare Safety Network criteria. Controls were randomly selected from a list of spinal surgery patients during the study period. Proportion matching by year was performed to ensure similar characteristics in practice, personnel and environment. There was no further matching between cases and controls. Both preoperative and intraoperative risk factors were examined. A total of 141 (2.67%) out of 3894 surgeries were found to have a surgical skin infection with 51% classified as deep, 10% as organ space, and 39% as superficial.

Univariate analysis found that diabetes, cardiac disease, obesity, ASA of 3 or more, Karnofsky score <60, previous spinal surgery, emergent/urgent spinal surgery, razor shaving were significant preoperative risk factors.

The intraoperative factors which were found to be significant included FIO2, procedure duration >75th percentile, instrumentation, lumbar-sacral level of surgery, posterior surgical approach, dural tear, postoperative CSF leak, transfusion.

After multivariate analysis independent risk factors included procedure duration >75th percentile, ASA score ≥3, lumbar-sacral level of surgery, posterior surgical approach, instrumentation, obesity, razor shaving before surgery, FIO2.

Analysis

This was one of the largest spinal SSI risk factor case control studies published. Many of the risk factors identified were similar to those previously reported in the literature. However, the authors sought to specifically examine modifiable

intraoperative risk factors. The strongest independent risk factor for SSI (OR 12) was an intraoperative FIO2 < 50%. Supplemental oxygen provides a necessary factor to the oxidative processes required by leukocytes to kill bacteria. Risk of SSI may therefore be significantly reduced by providing higher intraoperative FIO2.

The authors also found obesity to be a significant independent risk factor for spinal SSI. This finding may also be related to tissue oxygenation which has been shown to be decreased in obese patients. It should be noted that the authors could not calculate the BMI and was instead determined on a clinical observation documented in the patient records.

An ASA ≥3 was also found to be a highly significant independent risk for SSI which mirrors the results of many previous studies which have confirmed that the ASA is a strong predictor of illness severity.

Although diabetes and perioperative glucose >126 mg/dl were found to be significant factors in the univariate analysis, this significance was not sustained after multivariate analysis. This has been attributed to the lack of serum glucose data on patients during the preoperative and intraoperative period. The authors also note that razor shaving prior to surgery was found to be a significant independent risk factor, further confirming CDC guidelines for Healthcare Infection Control Practices Advisory Committee. From a surgical standpoint the authors demonstrated that a posterior approach, lumbar sacral level of surgery, duration of the procedure, and the use of instrumentation were all independent risk factors for SSI. This information corroborates what has been demonstrated in several smaller series.

This study is limited by its retrospective nature as well as by the missing data, specifically perioperative glucose levels, BMI for diagnosing obesity, and possible data from controls if they did not return to follow-up with the initial surgeon. However, it is still one of the larger series published and identifies possible modifiable risk factors to reduce the risk of SSI.

Synthesis

The effect on morbidity, mortality and hospital length stay associated with postoperative surgical site infections from the spine mirrors the importance of its study, causing a vast impact in patients' lives and health care costs. Because of the potentially high incidence in certain spinal surgeries, risk factors must be identified and minimized to decrease the hazard of infection. The review of these papers exhibits classic risk factors that should be covered by the existing protocols and defines issues that require future study. The impact of perioperative blood glucose, the use of vasodilators in patients receiving radiation therapy and the optimization of anesthetic parameters during surgery, should be the focus of upcoming research protocols and advances in the control of infection post spinal surgery. It is important that the patients analyze the risk and benefits of different treatments options, understanding the risks associated with surgical site infections and warning signs to be monitored in the postoperative period.

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