Research Article

Bacterial colonization of epidural catheters used for short-term postoperative analgesia: a microbiological examination and risk factor analysis

Mayank Chansoria[1], Sanjay K Singh[2], Ashish Sethi[1], Neha Vyas[3], Dilip Chandar[1], Ruchir Khare[4]

[1]Department of Anaesthesia, NSCB Medical College, Jabalpur, Madhya Pradesh, India.
[2]Registrar, RML, New Delhi, India.
[3]Consultant Endodontist, SS Medical College, Jabalpur, Madhya Pradesh, India.
[4]Department of Biochemistry, NSCB Medical College, Jabalpur, Madhya Pradesh, India.
Correspondence to: Mayank Chansoria, E-mail: mayankchansoria@gmail.com

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Abstract

Background: Epidural catheter-related infections are very rare, but if occurs, the complications are debilitating and life-threatening. The route by which the infection spreads is still under debate with the prime suspected route being direct spread with migration along the epidural catheter.

Objective: To critically analyze the incidence of epidural catheter-related infections, correlate the proposed risk factors leading to infection, and come up with a time frame at which the catheter should be ideally removed.

Material and Methods: A prospective observational study was done to study the incidence of epidural catheter-related infections and to find the bacteriological profile associated with epidural catheter-related infections. Ninety patients of ASA I and II aged between 18 and 65 years scheduled for elective surgeries requiring epidural catheter for intraoperative and postoperative analgesia were randomly allocated into three groups. Groups I, II, and III consisted of 30 patients each, and the epidural catheters were removed aseptically after 24, 48, and 72 h, respectively, and the catheter tips were sent for microbial culture examination.

Result: There was no incidence of epidural infections during the whole study. The incidence of bacterial colonization over epidural catheter tip in our study was 7.1% with "coagulase-negative *Staphylococcus epidermidis*" as the most common organism. Among the various risk factors studied, we found significant correlation only to that of the duration of catheter in situ with that of the positive catheter tip cultures, with 85.7% of the positive cultures from group III.

Conclusion: It is not advisable to allow the epidural catheters to be in situ for more than 72 h to avoid the chances of epidural catheter-related infections.

KEY WORDS: Bacterial colonization, epidural catheters, postoperative analgesia

Introduction

Epidural analgesia is one of the most common methods used for providing intraoperative and postoperative analgesia.

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Although it is regarded as a safe procedure, it can lead to serious complications such as epidural abscess, meningitis, osteomyelitis, and neurologic injury.[1] Epidural abscess is a serious complication, which, if not diagnosed and treated promptly in time, may lead to debilitating or life-threatening complications. The route by which the infection spreads to the epidural space is still unresolved. Hayek and Goomber[1] proposed various routes of infection spread such as direct spread from skin flora with migration along the catheter, contamination of the infusate, and hematogenous spread from a distant source, with prime suspicion given to that of direct spread from skin flora with migration along the epidural catheter. Various risk factors such as age, preexisting diseases such as diabetes

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mellitus, malignancy, drug abuse, alcoholism, and sepsis, medical treatment compromising the immune response, site of catheter insertion, and technically difficult catheter insertion are suspected to play a role in predisposing for catheter-related infection.[2] Although the occurrence of epidural catheter-related infection has been widely acknowledged and studied, to the best of our knowledge, we found paucity of literature regarding the time frame at which the infection rate is maximum and an ideal time frame above which the catheter should not be kept in situ. This study was done to critically analyze the incidence of epidural catheter-related infections, correlate the proposed risk factors leading to infection, and come up with a time frame at which the catheter should be ideally removed.

Materials and Methods

After obtaining institutional ethics committee approval, a single-center randomized prospective observational study was done in Department of Anesthesiology and Critical Care, Netaji Subash Chandra Bose Medical College and Hospital, Jabalpur, Madhya Pradesh, India, from a time period of October 2012 to October 2013. An informed written consent was taken from all the patients who were involved in the study.

In total, 90 ASA I and II patients, aged between 18 and 65 years, who were in need of intraoperative and postoperative analgesia by using epidural catheter were included into the study. Patients with active systemic infections requiring emergency procedure; pregnant women; patients aged older than 65 years or younger than 18 years; patients with routine contraindications for epidural catheter placement such as bleeding diathesis, hypovolemia, local or systemic sepsis, severe stenotic valvular heart disease, acute neurological disease, or raised intracranial pressure; and patients who refused to give consent were excluded from study. They were randomly allocated by lottery system into three groups, each consisting of 30 patients:

- Group I: 30 patients in whom the epidural catheter was planned to be removed after 24 h;
- Group II: 30 patients in whom the epidural catheter was planned to be removed after 48 h;
- Group III: 30 patients in whom the epidural catheter was planned to be removed after 72 h.

Among the total 90 patients studied, 48 were men and 42 women. Epidural catheters were placed in all the patients immediately before induction of anesthesia and before surgery at a level suitable to cover the corresponding dermatome of surgical incision. Standard procedure during catheter insertion included the use of sterile gloves and drapes and wearing of caps and face masks. All patients were placed in sitting position. Skin preparation was done with sterile povidone–iodine solution, followed by 70% alcohol, allowing the skin to dry before the epidural catheterization was started. The epidural catheter (18 gauges; PORTEX) were placed using a Tuohy needle (18 gauges) in the desired level through median approach by using loss of resistance technique. All the catheters were threaded with bacterial filters.

All catheters were tested for intravascular or subarachnoid placement by using a 3 mL of 2% lidocaine with epinephrine (1:200,000) as a test dose. Catheter was fixed in place by a clear sterile adhesive dressing over the site of needle puncture and an adhesive dressing over the patient's back. Each and every patient under the study was visited by the principle researcher and inspected for any signs of epidural space infection such as fever, neck pain, pain or tenderness at the site of epidural catheter insertion, or weakness in the lower extremities. The dressings were inspected every 24 h for all the patients and changed if there were any soakings or accidental removal.

A uniform antibiotic protocol of injection ceftriaxone (IV, 1 g BD) was administered to all the study subjects until the removal of epidural catheter. The selection of ceftriaxone as the antibiotic was based on the hospital policy for antibiotic usage in the postoperative patients.

The epidural catheter were removed after 24 h in group I, 48 h in group II, and 72 h in group III from the time of insertion. The distal 2 cm of the catheters were aseptically cut with sterile scissors keeping the tip of the catheter upward and away from the skin surface. The cut portion was transported in a sterile tube for immediate culture on to the culture medium in the microbiology laboratory.

Catheter tips received in the laboratory were suspended in 1 mL of sterile saline solution and shaken vigorously in a Cyclomixer (Remi, India). Then, 50 μL of the solution was plated onto nutrient agar plates using pour plate technique. The plates were incubated at 37°C for 48 h. After 48 h, the colonies appearing onto the plate were counted using a microprocessor-based colony counter (EI, India). The plate count was converted to colony forming unit (CFU) per milliliter by multiplying with the dilution factor of 20. The colonies appearing onto the plates were isolated aseptically and identified using the standard biochemical tests. The identification of the bacteria was based on colony characters, basic biochemical tests, and specific identification tests. Positive cultures were defined as culture plates showing $>10^{15}$ CFU.

Clinical data included patient characteristics, comorbidities, level of epidural catheter insertion, number of attempts taken for insertion, number of times the dressings got changed, study subjects with signs and symptoms of epidural space infections, and cultural and microbiological characteristics of the inoculums. The data were analyzed using IBM SPSS, version 20, Student *t* test, and Fischer exact test.

Results

Table 1 shows the demographic parameters of the patients who were included in the study, and the groups were comparable in terms of age, height, weight, and sex. There were no signs or symptoms of epidural space infections or signs of local inflammation at the site of insertion in any of the 90 patients studied. Although there was no incidence of

epidural space infection in any of the patients studied, we found positive cultures in seven patients (7.7%) with *Staphylococcus epidermidis* (*n* = 5, 71.4%) as the most common organism along with *Escherichia coli* (*n* = 1) and *Pseudomonas* aeruginosa (*n* = 1) in the positive cultures.

Figure 1 shows the number of positive cultures among the study groups, with maximum number of positive culture seen in group III (*n* = 6) wherein the catheter was allowed in the epidural space for 72 h. There was a single positive culture in group II wherein the catheter was removed after 48 h, and no positive cultures in group I where the catheter was removed after 24 h. This showed a statistically significant correlation (*p* = 0.005) between the duration of catheter placement and positive tip cultures, with chances of colonization more in group III.

Table 2 shows the microbiological characteristics in the positive cultures among the study groups. *S. epidermidis* accounted for 71% (*n* = 5) of the positive culture, with the majority (*n* = 4) in group III patients. There was a single positive culture for *E. coli* and *P. aeruginosa* in group III patients. There was a single positive culture for *Staphylococcus aureus* in group II patients.

Table 3 shows the incidence of colonization of epidural catheter tip between diabetic and nondiabetic patients. When comparing diabetic and nondiabetic patients within the study groups, we found a *p* value of 0.27 (i.e., >0.05), which shows that presence of diabetes was not significantly correlated with the chances of occurrence of bacterial colonization over epidural catheter tips.

Table 4 shows the correlation between the incidence of colonization and alcoholism. Of the total 21 patients who were found to consume alcohol in our study, only three (14.3%) patients showed culture-positive catheter tip. In group III, among seven alcoholic patients, only two (28.6%) patients showed culture-positive catheter tip, and in group II, of the eight alcoholic patients, only one (12.5%) patient revealed culture-positive catheter tip. None of the alcoholic patient in group I showed bacterial colonization over catheter tip, with a *p* value of 0.34 (i.e., >0.05). Hence, we conclude that alcoholism does not have a statistically significant impact on bacterial colonization over epidural catheter tip.

Table 5 shows the comparison between the presence of malignancy and bacterial colonization over epidural catheter tip in our study. In our study, of the three cases of malignancy, only one case showed positive culture over catheter (33.3%; *p* = 0.21, i.e., >0.05). This shows that the presence of malignancy does not have a statistically significant correlation with bacterial colonization over catheter tip.

Figure 2 shows the relation between the number of attempts taken during epidural catheter placement and bacterial colonization over catheter tip. Of the seven culture-positive catheter, maximum numbers of colonization (48.2%) was associated with catheters placed in two attempts and minimum (0%) with catheters placed in three attempts (*p* = 0.62, i.e., >0.05). It shows that the number of attempts taken during epidural catheter placement was not significantly related with bacterial colonization over epidural catheter.

Figure 3 shows the comparison of C-reactive protein (CRP) levels between the study subjects with positive epidural catheter tip cultures and study subjects with sterile epidural catheter growth. The mean CRP levels among cases with sterile catheter was 1.8 ± 0.87 (with the range of 0.7–3.8) and among cases with colonized catheter was 2.29 ± 1.1 (with the range of 1.02–3.8). Although the difference between both was not statistically significant, the patients with positive catheter tip cultures showed a comparatively mild rise in CRP levels.

Table 6 shows the comparison between total leukocyte count (TLC) and bacterial colonization over epidural catheter. Of the total 90 patients, 85 patients were found to have TLC within normal range. Of these 85 patients, seven (8.2%) patients showed bacterial colonization over epidural catheter, and 78 (91.8%) patients showed sterile catheter. None of the five patients with TLC more than >11,000 developed bacterial colonization over epidural catheter. The *p* value was 0.504, which showed colonization was more in patients with normal TLC levels, but this was statistically insignificant, at 95% confidence level.

Figure 4 shows the TLC levels in patients with positive epidural tip cultures. The TLC levels were within the normal range in all the seven patients.

Discussion

There was no incidence of epidural space infection in our study. But, in our study, we found an incidence of positive epidural catheter tip cultures among 7.1% of the studied patients, which is comparable with previous studies conducted by Yuan et al.,[2] Srivastava et al.,[3] and Trojanowski and Janicki.[4] The most common organism cultured is coagulase-negative *S. Epidermis*, which amounted for 71% of the positive cultures, which is similar to that of the studies conducted by Yuan et al.,[2] Srivastava et al.,[3] Trojanowski and Janicki,[4] Darcy et al.,[5] Steffen et al.,[6] Sahay et al.,[7] and Kostopanagiotou et al.[8] Along with it, we found positive cultures for *E. coli* and *P. Aeruginosa*. This shows that epidural space can also be colonized by virulent microorganisms; hence, we concur with previous studies of Srivastava et al.,[3] Trojanowski and Janicki,[4] Darcy et al.,[5] and Steffen et al.[6]

Our study is unique in comparison with the previous studies[1–8] because we followed a uniform antibiotic protocol in all the study subjects. The use of a common antibiotic ceftriaxone did not yield us negative epidural catheter tip cultures. The bacterial flora that were obtained by epidural tip cultures were usually covered or contained by ceftriaxone,[9] implying that parenteral antibiotic administration show less protective role over epidural catheter-related infections.

CRP and TLC levels were used to predict infection, but there was no statistically significant difference in levels between those of patients with positive tip cultures and those of patients with negative cultures. As there was no incidence of epidural space infection in our study, we could not conclude about the predictive value of the above two tests in the epidural space infections.

Table 1: Demographic parameters

Parameters	Group I	Group II	Group III
Patients sample size	30	30	30
Age, mean (years)	45.1 ± 12.4	43.9 ± 14	44.4 ± 13
Mean height (cm)	158.8 ± 7.6	160.6 ± 6.1	163.8 ± 7.4
Mean weight (kg)	64.7 ± 8.1	67.5 ± 6.7	67.9 ± 9.1
Female	13	17	14
Male	17	13	16

Table 2: Various microorganisms cultured in different study groups

Organisms cultured	Group I	Group II	Group III
E. coli	0	0	1
Pseudomonas	0	0	1
S. epidermidis	0	1	4

Table 3: Comparison of bacterial colonization among diabetic and nondiabetic patients

Group	No. of diabetic patients	No. of colonizations	No. of nondiabetic patients	No. of colonizations
Group I	4	0	26	0
Group II	4	0	26	1
Group III	4	0	26	6

Table 4: Comparison between alcoholism and bacterial colonization

Group	No. of alcoholic persons	No. of colonization	%
Group I	6	0	0.0
Group II	8	1	12.5
Group III	7	2	28.6
Total	21	3	14.3

Table 5: Comparison of presence of malignancy with bacterial colonization

Group	No. of malignancy	No. of colonizations	%
Group I	1	0	0.0
Group II	1	1	100.0
Group III	1	0	0.0
Total	3	1	33.3

Table 6: Comparison between total leukocyte count and bacterial colonization

TLC count	Colonization present	%	Colonization absent	%	Total
Normal (4,000–11,000)	7	8.2	78	91.8	85
>11,000	0	0.0	5	100.0	5
Total	7	7.8	83	92.2	90

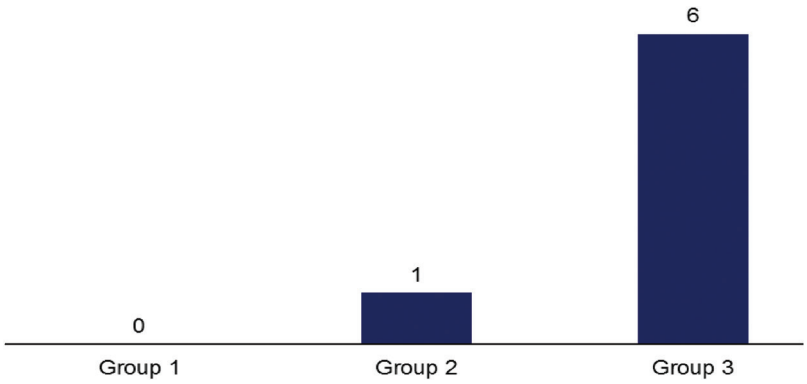


Figure 1: Number of colonization in various groups.

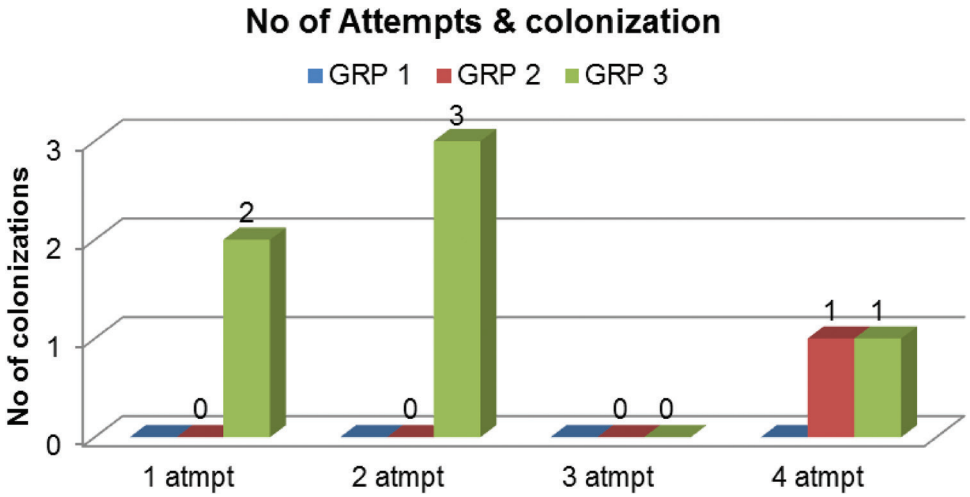


Figure 2: Number of attempts during catheterization and bacterial colonization.

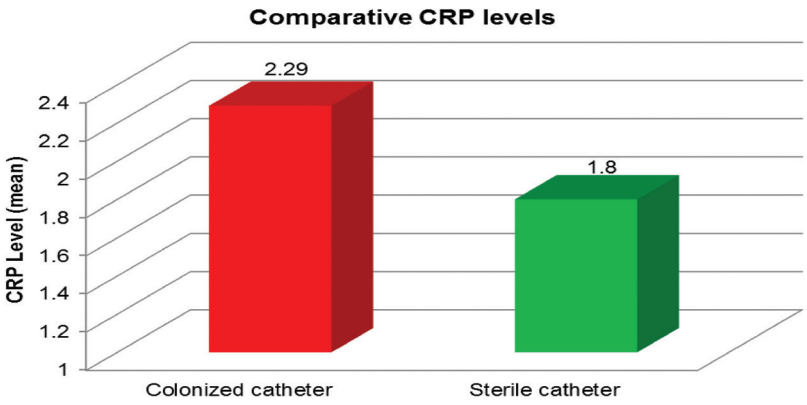


Figure 3: Comparing CRP levels in catheters with and without colonization.

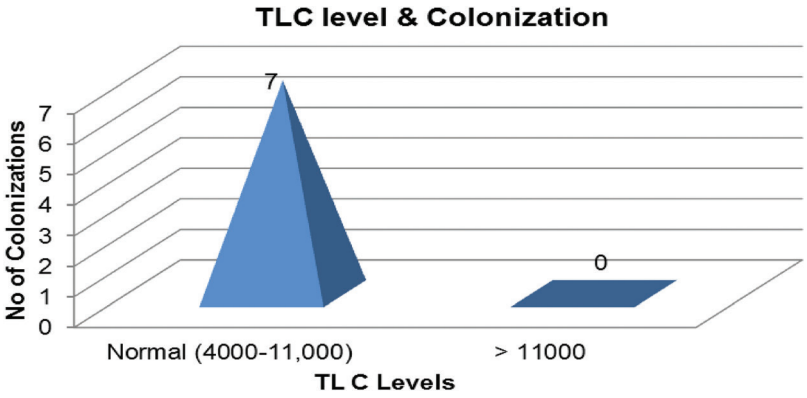
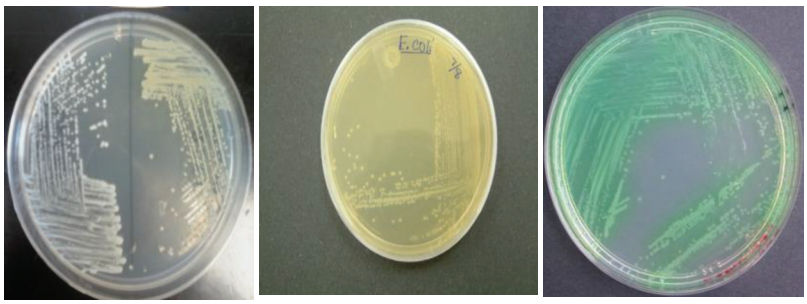


Figure 4: Total leukocyte count in patients with positive catheter tip cultures: plate 1, colonies of *Staphylococcus epidermis*; plate 2, colonies of *Escherichia coli*; and plate 3, *Pseudomonas aeruginosa.*



(1) (2) (3)

Although we found positive epidural tip cultures, there was no incidence of epidural space infection among the study subjects with positive epidural catheter tip colonizations. Thus, positive culture is not a reliable predictor of epidural space infection as shown by previous studies.[3–8] We conclude that routine cultures of the epidural catheters possess no predictive value for identifying epidural space infection and it should not be done unless deemed necessary.

Among the various risk factors studied, we found significant correlation only to that of the duration of catheter in situ with that of the positive catheter tip cultures. In total, 85.7% of the positive cultures were from group III study subjects, in whom the catheter was left in situ for 72 h. Longer the catheter remained in epidural space; more were the chances of colonization as shown by the previous studies by Srivastava et al.,[3] Wang et al.,[10] Holt et al.,[11], and Steffen et al.[6] We concluded that epidural catheters should not kept in situ for more than 3 days unless deemed as recommended by Hayek and Goomber[1] for minimizing the incidence of epidural space infections.

Our study did not show any statistically significant correlation between other risk factors such as diabetes, malignancy, chronic alcoholism, and increased number of attempts with that of the incidence of the epidural catheter colonization. None of our study subjects showed risk factors such as chronic drug abuse and under immunocompromising drugs; so, little can be said about the impact of above-mentioned two risk factors on the epidural catheter colonization.

Conclusions

We conclude that there is no statistically significant correlation between other risk factors such as diabetes, malignancy, chronic alcoholism, and increased number of attempts with that of the incidence of the epidural catheter colonization. But, there is a significant correlation only to that of the duration of catheter in situ with that of the positive catheter tip cultures. The positive culture is not a reliable predictor of epidural space infection. The limitations of our study include small sample size and patients were not followed up after 14 days; so, very little data available to conclude on the incidence of late-onset epidural space infections. We, however, acknowledge that our sample size is relatively small, and these findings need to be corroborated by studies involving larger numbers of patients.

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