International Journal of Research in Medical Sciences
Ahmmed T et al. Int J Res Med Sci. 2024 Jun;12(6):1879-1886
www.msjonline.org
pISSN 2320-6071 | eISSN 2320-6012
DOI: https://dx.doi.org/10.18203/2320-6012.ijrms20241531

Original Research Article

Efficacy of per operative use of powdered vancomycin in reduction of early post-operative superficial surgical site infection in single level prolapsed lumber intervertebral disc surgery

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Received: 09 April 2024
Accepted: 14 May 2024

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ABSTRACT

Background: Decompression (fenestration and discectomy) of lumber disc herniation is one of the most common surgical procedures done by neurosurgeons. The aim of this study was to evaluate the efficacy of per operative use of powdered vancomycin in reduction of early post-operative superficial surgical site infection in single level prolapsed lumber intervertebral disc surgery.
Methods: This was a Quasi-experimental type of study carried out in the Department of Neurosurgery, Bangabandhu Sheikh Mujib Medical University, Dhaka, Bangladesh from October 2022 to September 2023.
Results: In this study, the mean age was 42.2±10.5 years, ranging from 20 to 60 years. The highest incidence of prolapsed lumbar intervertebral disc (PLID) was in the vancomycin group among patients aged 41-60, with a male-to-female ratio of 1.7:1. Most PLID cases (59.4%) occurred at the L4/5 level. Out of 32 patients, only four (no vancomycin group) had an ESR above 75 mm/hr. On the 30th postoperative day, significantly increased CRP levels and signs of infection were observed. Among those with purulent discharge, 50% had Staphylococcus aureus, 25% had Staphylococcus epidermidis, and 25% showed no pathogen growth.
Conclusions: In this study, we found that there is a significant effect of topical application of powdered vancomycin in addition to systemic antibiotic prophylaxis over the subcutaneous tissue following fenestration and discectomy in single level prolapsed lumber intervertebral disc and reduction in the incidence of superficial surgical site infection.

Keywords: CRP, ESR, PLID, TC-WBC, SSI

INTRODUCTION

Previously, patients after any surgery commonly developed post-operative "irritative fever" followed by purulent discharge from their wound, associated with overwhelming sepsis and often death. However post-operative morbidity and mortality due to infections decreased after Joseph Lister introduced the principle of anti-sepsis in the late 1860s. Generally, surgical site infections (SSIs) is seen in about 2% to 20% of the surgical patient which is one of the most common and costly health-associated infections (HAI), surgical site infections increased the risk of death 2 to 11 times in patients with infection compared with patients without

infection.[1,2] SSIs are directly attributable to 77% of deaths in surgical patients. Moreover, it increases by approximately 7 to 11 additional post-operative hospital - days.[3] SSIs are responsible for $3.5 to $10 billion increase in annual healthcare expenditures.[4] The centers for disease control (CDC)'s national nosocomial infections surveillance (NNIS) system has developed standardized surveillance criteria for defining SSIs. SSIs are broadly classified into 2 groups: incisional and organ/space. Incisional SSIs are further divided into those involving only skin and subcutaneous tissue which is known as superficial incisional SSI and those involving deeper soft tissues of the incision which is known as deep incisional SSI. Organ/space SSIs can involve any part of the body other than incised body wall layers, that was opened or manipulated during operation.[5] *Staphylococcus aureus* and *Staphylococcus epidermidis* are the most common pathogens to be inoculated directly into the wound during surgery.[6] 32% of SSIs were caused by *Staphylococcus aureus* of which 88% were deep incisional or organ space infections.[7] The pathogen load is an important defining factor, such as quantitively >105 microorganisms/gram of tissue significantly increasing the risk of SSI.[8] However, the presence of foreign material at the site needs a much smaller inoculum of contaminating microorganisms. For example, only 100 staphylococci/gram of tissue can produce SSI when contaminated on a silk suture.[9] Endogenous flora mostly originating from the patient's skin can be responsible for most SSIs, which is attributed to many contributing factors to these serious infections, like surgical personnel, the operating room environment, surgical instruments and many other exogenous sources.[10] Decompression of lumber disc herniation by fenestration and discectomy is one of the most common surgical procedures in neurosurgery. The incidence of SSIs following PLID surgery is 0.7 to 6%.[11] So, surgeons should make a great effort to minimize risk factors for wound infections before and after PLID surgery. While perioperative antibiotic prophylaxis as a means of lowering infection rates after PLID surgery has been well described, there is a paucity of literature with respect to other adjunct measures to prevent post-operative infection. The powdered form of antibiotic deposited directly into the surgical wound prior to closure may be a successful means to reduce post-operative deep SSIs. Directly depositing the powdered form of the antibiotic into the operative site theoretically achieves the highest level of antibiotic concentration in the wound.[12] The objective of this study was to evaluate the efficacy of per operative use of powdered vancomycin in reduction of early post-operative superficial surgical site infection in single level prolapsed lumber intervertebral disc surgery.

METHODS

This was a Quasi-experimental type of study carried out in the Department of Neurosurgery, Bangabandhu Sheikh Mujib Medical University, Dhaka, Bangladesh from October 2022 to September 2023.

All patients of single level prolapsed lumbar intervertebral discs who underwent open technique fenestration and discectomy who fulfilled the selection criteria were allocated as the vancomycin group and no vancomycin group. All 32 patients were taken for a study where 16 patients were in the vancomycin group (intervention) and 16 patients were in no vancomycin group (control).

Inclusion criteria

Patients (age ≥18, gender: male, female) who underwent fenestration and discectomy surgery in single level prolapsed lumbar intervertebral disc during the data collection period were included.

Exclusion criteria

Recurrent PLID, patients who were hypersensitive to vancomycin and penicillin, patients who had features of systemic infection, and patients who had chronic illness and immune-compromised were excluded.

Data collection

Patient's data were recorded in a predetermined data sheet. Patients were informed in detail about the study, its merit and demerit in easy and understandable language and then informed consent was taken. Also assured that all the information and records will be kept confidential and the procedure will be helpful for both the attending neurosurgeons and patients in making decisions for further management. Patients of the vancomycin group who underwent single level open technique fenestration and discectomy surgery were applied per operative powdered vancomycin over subcutaneous tissue to assess the efficacy of powdered vancomycin in reduction of early post-operative superficial surgical site infection.

Prior to commencement of the study, the respective authority was approved the research protocol. All the patients included in this study were informed about the nature, risks and benefits of the study. Confidentiality was maintained. Proper permission was taken from the department and institution concerned for the study.

Statistical analysis

Data were processed and analyzed using computer software SPSS (Statistical Package for Social Sciences) version 25. Student's independent t-test or chi-square test will be done as appropriate for analysis of data. Statistical significance will be set at p-value <0.05.

RESULTS

A quasi-experimental study was carried out to determine the efficacy of per-operative use of powdered vancomycin in reduction of early post-operative superficial surgical site infection in single level prolapsed

lumber intervertebral disc surgery. A total of 32 patients who met the inclusion and exclusion criteria were admitted to the Department of Neurosurgery at Bangabandhu Sheikh Mujib Medical University (BSMMU) in Shahbag, Dhaka. And allocated as vancomycin group (intervention) and no vancomycin group (control) who had undergone single level PLID surgery (aged ≥18 years).

Table 1 shows the distribution of patients by age in two groups. Among patients, 43.8% in 20-40 aged were in the vancomycin group and 37.5% were in no vancomycin group, while 56.3% in 41-60 aged in both groups. The mean age was 41.1±7.72 years in vancomycin group, while mean age was 43.3±12.8 years in no vancomycin group. No significant differences of mean age between the groups (p>0.05).

Table 1: Distribution of the study patients according to their age in two groups (n=32).

Age group (years)	Vancomycin group (intervention) (n=16) N (%)	No vancomycin group (control) (n=16) N (%)	Total (n=32) N (%)	P value
20-40	7 (43.8)	6 (37.5)	13 (40.6)	0.718
41-60	9 (56.3)	9 (56.3)	18 (56.3)	1.000
>60	0 (0.0)	1 (6.3)	1 (3.1)	0.309
Total	16 (100.0)	16 (100.0)	32 (100)	
Mean±SD	41.1±7.72	43.3±12.8	42.2±10.5	0.563

Obtained by Unpaired t-test, p<0.05 considered as a level of significance, Vancomycin group: With use of per-operative powdered vancomycin, No Vancomycin group: Without use of per-operative powdered vancomycin

Table 2: Distribution of the study patients according to their gender in two groups (n=32).

Gender	Vancomycin group (intervention) (n=16) N (%)	No vancomycin group (control) (n=16) N (%)	Total (n=32) N (%)	P value
Male	10 (62.5)	9 (56.3)	19 (59.4)	0.719
Female	6 (37.5)	7 (43.8)	13 (40.6)	
Total	16 (100.0)	16 (100.0)	32 (100)	

Obtained by Chi-square test, p<0.05 considered as a level of significance

Table 3: Distribution of the study patients according to PLID level in two groups (n=32).

PLID	Vancomycin group (intervention) (n=16) N (%)	No vancomycin group (control) (n=16) N (%)	Total (n=32) N (%)	P value
L 4/5	10 (62.5)	9 (56.3)	19 (59.4)	0.559
L 3/4	1 (6.3)	3 (18.8)	4 (12.5)	
L 5/S1	5 (31.3)	4 (25.0)	9 (28.1)	
Total	16 (100.0)	16 (100.0)	32 (100)	

P-value obtained by Chi-square test, p<0.05 considered as a level of significance

Table 2 shows the gender distribution of study patients in two groups. The data indicates that 62.5% were male patients in the vancomycin group, and 56.3% were male in the vancomycin group. Likewise, 37.5% were female patients in the vancomycin group, and 43.8% were female in the no vancomycin group. No significant association was observed in terms of gender between the groups (p>0.05).

Table 3 shows the distribution of study patients according to the level of prolapsed lumbar intervertebral disc (PLID) in both groups. In the vancomycin group, 62.5% had a prolapsed disc at the L4/5 level, 6.3% at L3/4, and 31.3% at L5/S1. In no vancomycin group, 56.3% had a prolapsed disc at L4/5, 18.8% at L3/4, and 25% at L5/S1. Analysis indicated no statistically significant differences in PLID distribution between the groups (p>0.05).

Table 4 shows an association of TC-WBC (total counts of WBC) of postoperative days (POD) between two groups. The data indicates no significant difference in the distribution of TC-WBC greater or lesser than 11,000/mm^3 between the groups on the 1st, 4th, 7th and 30th POD (p>0.05).

Table 5 shows the association of erythrocytic sedimentation rate (ESR) between the two groups. The results indicate no significant difference in the distribution of ESR values higher or lower than 75 mm/hour between the groups on the 1st, 4th, and 7th POD but in the 30th POD, all patients in the vancomycin group less than 75 mm/hour and 4 patients of no vancomycin group more than 75mm/hour which is statistically significant p=0.033.

Table 4: Association of TC-WBC between two groups (n=32).

Total count	Vancomycin group (intervention) (n=16) N (%)	No vancomycin group (control) (n=16) N (%)	Total (n=32) N (%)	P value
1st POD				
>11000 /mm^3	4 (25.0)	2 (12.5)	6 (18.8)	0.365
<11000 /mm^3	12 (75.0)	14 (87.5)	26 (81.3)	
4th POD				
>11000 /mm^3	1 (6.3)	2 (12.5)	3 (9.4)	0.544
<11000 /mm^3	15 (93.8)	14 (87.5)	29 (90.9)	
7th POD				
>11000 /mm^3	1 (6.3)	2 (12.5)	3 (9.4)	0.544
<11000 /mm^3	15 (93.8)	14 (87.5)	29 (90.9)	
30th POD				
>11000 /mm^3	0 (0.0)	2 (12.5)	2 (6.3)	0.144
<11000 /mm^3	16 (100.0)	14 (87.5)	30 (93.8)	

P-value obtained by Chi-square test, p<0.05 considered as a level of significance

Table 5: Association of ESR between two groups (n=32).

ESR	Vancomycin group (intervention) (n=16) N (%)	No vancomycin group (control) (n=16) N (%)	Total (n=32) N (%)	P value
1st POD				
>75 mm 1st hour	0 (0.0)	0 (0.0)	0 (0.0)	-
<75 mm 1st hour	16 (100)	16 (100)	32 (100)	
4th POD				
>75 mm 1st hour	0 (0.0)	0 (0.0)	0 (0.0)	-
<75 mm 1st hour	16 (100)	16 (100)	32 (100)	
7th POD				
>75 mm 1st hour	0 (0.0)	0 (0.0)	0 (0.0)	-
<75 mm 1st hour	16 (100)	16 (87.5)	32(93.7)	
30th POD				
>75 mm 1st hour	0 (0.0)	4 (25.0)	4 (12.5)	0.033
<75 mm 1st hour	16 (100.0)	12 (75.0)	28 (87.5)	

P-value obtained by Chi-square test p<0.05 considered as a level of significance

Table 6 shows the association of CRP (C-reactive protein) levels between vancomycin group and no vancomycin group. In both groups, there was a higher CRP level on the first postoperative day (1st POD), indicating a strong inflammatory response following surgery. For the both 4th and 7th POD, CRP levels were low (<10 mg/l) in both groups. so, there is no significant difference between the two groups. However, 4 (25.0%) patients of no vancomycin group in the 30th POD, had high CRP (>10 mg/l) levels indicating a significant difference between the two groups in the 30th POD = p<0.033.

Table 7 shows the association of signs with superficial SSI between vancomycin group and no vancomycin group. The results demonstrate a significant difference in the occurrence of localized pain, localized swelling and purulent discharge from the superficial surgical site is statically significant p= 0.003 (p<0.05). None of the patients in the vancomycin group had the signs of SSI, while 4 (25.0%) patients in no vancomycin group had the signs of superficial SSI.

Table 8 shows the association of superficial surgical site infections (SSIs) between vancomycin group and no vancomycin group. None of the patients in the vancomycin group had a superficial SSI, while 4 (25.0%) patients in no vancomycin group had a superficial SSI. The incidence of superficial SSI was significantly lower in vancomycin group where per operative powdered vancomycin was used, in comparison to no vancomycin group where it was not (p<0.05). Table 9 presents the distribution of patients by organism among the patients with superficial SSIs. Out of four, two patients had *Staphylococcus aureus* (50.0%), one patient had *Staphylococcus epidermidis* (25.0%), and one patient had no organism identified (25.0%).

Table 6: Association of CRP between two groups (n=32).

CRP	Vancomycin group (intervention) (n=16) N (%)	No vancomycin group (control) (n=16) N (%)	Total (n=32) N (%)	P value
1st POD				
High (>10 mg/l)	16 (100.0)	16 (100.0)	32 (100)	-
Low (<10 mg/l)	0 (0.0)	0 (0.0)	0 (0.0)	
4th POD				
High (>10 mg/l)	0 (0.0)	0 (0.0)	0 (0.0)	-
Low (<10 mg/l)	16 (93.8)	16 (75.0)	32 (100)	
7th POD				
High (>10 mg/l)	0 (0.0)	0 (0.0)	0 (0.0)	-
Low (<10 mg/l)	16 (100)	16 (100)	32 (100)	
30th POD				
High (>10 mg/l)	0 (0.0)	4 (25.0)	4 (12.5)	0.033
Low (<10 mg/l)	16 (100.0)	12 (75.0)	28 (87.5)	

P-value obtained by Chi-square test, p<0.05 considered as a level significance

Table 7: Association of signs of the superficial SSI between two groups (n=32).

Signs	Vancomycin group (intervention) (n=16) N (%)	No vancomycin group (control) (n=16) N (%)	Total (n=32) N (%)	P value
Localized pain	0 (0.0)	4 (25.0)	4 (12.5)	0.003
Localized swelling	0 (0.0)	4 (25.0)	4 (12.5)	0.003
Purulent discharge	0 (0.0)	4 (25.0)	4 (12.5)	0.003

P-value obtained by Chi-square test, p<0.05 considered as a level significance

Table 8: Association of superficial SSI between two groups (n=32).

Superficial SSI	Vancomycin group (intervention) (n=16) N (%)	No vancomycin group (control) (n=16) N (%)	Total (n=32) N (%)	P value
Yes	0 (0.0)	4 (25.0)	4 (12.5)	0.033
No	16 (100.0)	12 (75.0)	28 (87.5)	
Total	16 (100.0)	16 (100.0)	32 (100)	

P-value obtained by Chi-square test, p<0.05 considered as a level significance

Table 9: Distribution of the patients by organism (n=4).

Name of organism	Number of patients	Percentage (%)
Staphylococcus aureus	2	50.0
Staphylococcus epidermidis	1	25.0
None	1	25.0
Total	4	100.0

DISCUSSION

The present study has been undertaken to see the efficacy of topical use of per-operative powdered vancomycin in reduction of early post-operative superficial surgical site infection in single level prolapsed lumber intervertebral disc surgery. This study was done in a few of country except the sub-continent. In this study, we found a significant difference in outcome (p value 0.033) between vancomycin group and no vancomycin group. Subject without vancomycin was statistically significant.

Surgical site infection following prolapsed lumber intervertebral disc surgery is an unwanted complication that we face in the hospital and might lead to increasing hospital stays and morbidity causing a financial burden to society, as well as for the country. Local application of powdered vancomycin in spine surgery has shown to be safe and effective in several studies. In our region, there is a chance of surgical site infection due to different factors like socio-economic status, poor nutritional status, poor hygiene, and lower education level of the patients. Surgical site infection causes increased morbidity and financial burden who underwent neurosurgical procedures like fenestration and discectomy.

In the present study, there are no significant differences in mean age between the two groups (p>0.05). The age of the majority population was in the range of 41 to 60 years which is supported by Machino et al stated that PLID appeared after the 40s and then increased further with age.[13] Because the elasticity and water content of the nucleus decreases with age. This finding was probably due to the young adults and middle-aged people mostly remain occupationally active. After a seventh decade of age body adjusts and prevents disc herniation as the discs gradually get atrophied.

In this study, there is no significant association of gender between the two groups where male patients were more (59.4%) in number than females (40.6%) who had undergone single level PLID surgery. A similar study previously done by Ansari et al that male patient was more (76%) than female (24%).[14] This finding was probably due to men being involved more in physically demanding work. So, they are more vulnerable to mechanical stress and physical injury than their female counterparts (house dwellers) in our region. So, men are more vulnerable to developed PLID than women. In our study, the level of PLID at L4/5 was higher than at other levels L5/S1 and L3/4. Ozgen et al discovered the most common level of PLID at L4/5 level which is similar to our study.[15] Analysis in this study indicates there are no statistically significant differences in PLID distribution between the groups p=0.559.

In this study, TC-WBC was higher among the patients who had surgical site infection than those with no infection but this was not statistically significant (p=0.144). Zare et al found that white blood cell (WBC) count elevation in less than 50% of cases of surgical site infection which is close to this study as 50% of the patients with surgical site infection developed elevation of TC-WBC. So, it is consequently an untrustworthy diagnostic marker.[16]

Anything that causes inflammation or infection increases the level of ESR. The ESR is an indicator for postoperative infection. However, postoperative ESR can increase due to muscle damage in patients without an infection. Zare et al mentioned that post-operatively ESR can increase up to 75 mm/hr and gradually reduce from 2 to 4 weeks.[16] The ESR in infected patients usually rises more than that during postoperative changes. In this study, results indicate no significant difference in the distribution of ESR values higher or lower than 75mm/hour between the groups on the 1st, 4th, and 7th POD but in the 30th POD, all patients in the vancomycin group had less than 75 mm in 1st hour and 4 patients of no vancomycin group had more than 75 mm/hour which is statistically significant p=0.033. CRP levels may be a useful marker for early detection of postoperative infections. In our study, had a higher CRP level in both groups in the 1st POD, and all patients in both groups had high CRP levels indicating a strong inflammatory response following surgery. For the 4th and 7th POD, the patient in both group's CRP levels was low. So, there is no significant difference between the two groups in both PODs. However, in the 30th POD, 4 (25.0%) patients in no vancomycin group had high CRP levels and all patients in the vancomycin group had normal CRP levels indicating a significant difference between two groups p<0.033. Nehring et al stated that a CRP level of more than 10.0 mg/dL indicates acute bacterial infections.[17] It was observed from the previous studies that the natural trend of CRP is to increase in the first 2-3 days followed by a sharp decline.[18] So, it was matched with our study that CRP level raised in 1st POD and after 4th POD, CRP level tends to reduce within normal value. Thus, our present study showed a significant association of raised serum CRP level in no vancomycin group on 30th POD following single level PLID surgery that is higher than the normal value. Therefore, CRP is a low-cost, easy but important tool for detecting surgical site infection.

There are some criteria that should be met to detect superficial surgical site infection. According to the CDC (2023) definitions of surgical site infection there may be present at least one of the following localized pain, localized swelling, erythema, and purulent discharge as signs of superficial surgical site infection. In this study, among the two groups, there is no mentioned signs of superficial SSI in the 1st, 4th and 7th and in the 30th POD of the vancomycin group but 4 patients of no vancomycin group developed signs of superficial SSI (localized pain, localized swelling, purulent discharge) in 30th POD which statically significant p= 0.003. So, the result of our study matches with the CDC (2023) criteria for early superficial surgical site infection.

In this present study, only 4 patients in the no vancomycin group developed superficial surgical site infection (25%) and there is no patient in the vancomycin group developed superficial surgical site infection (0%) in the early post-operative period which is statistically significant p=0.033. A study matched ours which was a recent retrospective study of 350 patients, where there was a significant reduction to 0% of Surgical site infection following the introduction of topical vancomycin mentioned by Ravikumar et al.[19] A cohort study of 150 patients by Abdullah et al found that the overall incidence of infection in the vancomycin group (intervention) was 1.3% and 6.7% in the vancomycin group (control).[6] Korinek et al found only 2 patients developed surgical site infection out of the 30 patients who received vancomycin prophylaxis.[20] A meta-analysis of surgical site infection where 2518 cases showed 2.8% reduction rate with local application of vancomycin where overall incidence was 4.1%. Over all incidence of SSI was variable ranging from 2 to 5 %.[21] In this study, the incidence of infection in the vancomycin group (intervention) was 0% and in no vancomycin group (control) was 12.5% which is more than in previous studies and may be due to low socioeconomic status, education or personal hygiene.

In the present study, 4 patients developed superficial surgical site infection in no vancomycin group (control) where the causative agents were identified in culture as *Staphylococcus aureus* in 2 (50%), *Staphylococcus epidermidis* in 1 (25.0%), and no growth of the pathogen in 1 patient (25.0%). A similar study by Chiang et al mentioned previously that the most common pathogen i.e.*Staphylococcus aureus, Staphylococcus epidermidis*.[21]

The pathogen that caused surgical site infection were methicillin-susceptible *S. aureus*, *Propionibacterium acnes*, coagulase-negative *S. aureus*, *P. acnes*, *Stenotrophomonas maltophilia* and *Streptococcus viridans* and methicilline resistant *Staphylococcus aureus* has been increasing.[6] Vancomycin is more effective against mainly methicillin-resistant pathogens which has been regarded as the first-line drug for the treatment of MRSA.[22]

Heller et al stated that intrawound vancomycin powder use has decreased the rate of acute Staphylococcal SSIs.[23] In this study, *Staphylococcus aureus*, and *Staphylococcus epidermidis* were found as causative organisms of early post-operative superficial surgical site infection in no vancomycin group (control) which were gram-positive organisms and no surgical site infection in the vancomycin group (intervention). So, we could hypothesize by our study, that vancomycin is very effective against gram-positive organisms like *Staphylococcus*.

CONCLUSION

In this study, we found that there is a significant association between topical application of powdered vancomycin and no application of powdered vancomycin over the subcutaneous tissue following fenestration and discectomy in single-level prolapsed lumber intervertebral disc and reduction in incidence of surgical site infection.

ACKNOWLEDGEMENTS

Authors would like to thank the Department of Neurosurgery, Bangabandhu Sheikh Mujib Medical University, Dhaka, Bangladesh.

Funding: No funding sources
Conflict of interest: None declared
Ethical approval: The study was approved by the Institutional Ethics Committee

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Cite this article as: Ahmmed T, Chowdhury D, Fatima K, Razib KO, Islam KS, Rahim MA, et al. Efficacy of per operative use of powdered vancomycin in reduction of early post-operative superficial surgical site infection in single level prolapsed lumber intervertebral disc surgery. Int J Res Med Sci 2024;12:1879-86.