

Original Article

To Compare the Effectiveness of Short-term Three Dose Perioperative Antibiotic Coverage during Decisive Period with Conventional Prolonged Postoperative Antibiotic Usage in Clean Elective Surgical Cases: An Indian Perspective

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ABSTRACT

Background: Surgical site infections are the most common postoperative complications and frequently cause morbidity and mortality. Different antibiotic regimens were evaluated as prophylaxis in wound infection following elective surgical procedures. Prophylactic antibiotics should be given to cover the “decisive period” which is a period after incision to mobilization of host defenses thus preventing an infection from developing. **Objectives:** The aim is to study the effectiveness of short-term antibiotic coverage during decisive period in the prevention of postoperative wound sepsis in clean surgical cases. **Materials and Methods:** The prospective randomized comparative study included 50 patients divided into two groups of 25 each. Group A (short-term ceftriaxone prophylaxis) patients received three doses of 1 g intravenous ceftriaxone. First dose 12 h, 2nd dose 1 h before operation and the 3rd dose was given 10 h after the operation. The Group B (conventional postoperative ceftriaxone prophylaxis) patients received postoperatively 1 g B. D intravenous ceftriaxone for 5 days. We compared the incidence of surgical site infection in two groups. **Study Period:** November 2014 to September 2016. A predesigned and pretested proforma was used to collect the data. Surgical sites were examined for 30 days. Robertson grading was used to assess the severity of infection. **Results:** Surgical site infection rate was 4% in Group A and 24% in Group B. The severity of infection was less in short-term prophylaxis group. Anemia, nutritional status, and use of drain were other factors associated with postoperative wound infections. **Conclusion:** Short course perioperative (three doses) ceftriaxone prophylaxis is sufficient in preventing wound infection. Prophylactic antibiotic should be given to cover the decisive period to prevent an infection from developing. The judicious use of antibiotics can reduce the cost, unnecessary prolonged exposure, side effects, and the emergence of resistant micro-organisms.

KEYWORDS: Ceftriaxone, clean wound, perioperative, surgical site infection

INTRODUCTION

Infections remain an important complication of surgical procedures despite increased knowledge about prevention and technological advances in modern surgery. Appropriate antibiotic prophylaxis is directed toward the most likely pathogens encountered during the surgery and should be administered before the skin incision is made.^[1] Perioperative antibiotic prophylaxis must not be continued beyond the day of surgery in clean elective surgical cases, that is, cases in which no inflammation is encountered and the respiratory,

alimentary, genital, or uninfected urinary tract is not entered.^[2]

The basic concept in preventive antibiotic use is “decisive period” during which antibiotics will be effective. This decisive period is temporary and lasts

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only a few hours. Operations begin and end within the decisive period.

There is a delay before host defenses can become mobilized after a breach in an epithelial surface, whether caused by trauma or surgery. The acute inflammatory, humoral, and cellular defenses take up to 4 h to be mobilized. This is called the “decisive period,” and it is the time when the invading bacteria may become established in the tissues. Strategies aimed at preventing infection from taking a hold become ineffective after this time. It is, therefore, logical that prophylactic antibiotics should be given to cover this period and that they could be decisive in preventing an infection from developing. The tissue levels of antibiotics should be above the minimum inhibitory concentration for the pathogens likely to be encountered.^[3]

The decision to use prophylactic antibiotic therapy must be based on balancing possible benefit against possible adverse effects. Indiscriminate use of antibiotics is discouraged because it may lead to the emergence of antibiotic-resistant strains of organisms or serious hypersensitivity reactions. In particular, prolonged use of prophylactic antibiotics may also mask the signs of established infections.^[4]

Prophylactic antibiotic therapy is no substitute for careful surgical technique using established surgical principles. Antibiotics can be used effectively only as adjuncts to adequate surgery.^[5] No evidence supports the practice of continuing prophylactic antibiotics until central lines, drains, and chest tubes are removed, and most regimens of prophylaxis are completed within 24 h of the time of incision. However, there is evidence of an increase in the recovery of resistant bacteria by this practice.^[1]

The differentiation between major and minor wound infection is important. There are various classifications to assess the severity of wound infection like Robertson classification in which severity of wound infection is assessed in grades.^[6] With the fear of developing wound infection after surgery, many surgeons administer antibiotics for prolonged period even in clean surgeries. This practice is not only expensive but also can lead to hospital-acquired infections.^[7] The purpose of conducting this study was to know whether prophylactic short course (three dose) perioperative administration of ceftriaxone be decisive in preventing an infection from developing. So that, it can decrease postoperative morbidity, shorten hospitalization, reduce the overall cost attributable to infection and prevent unnecessary use of antibiotics for long periods.

Aims and objectives

To study the effectiveness of short course (three dose) perioperative ceftriaxone antibiotic regimen in the

prevention of postoperative wound sepsis in clean surgical cases.

MATERIALS AND METHODS

The prospective, randomized and comparative study was conducted after approval from the Institutional Ethical Committee on fifty admitted patients who underwent clean elective surgical procedures in Government Medical College, Amritsar from November 2014 to September 2016.

Inclusion criteria

All cases who underwent clean elective surgical procedures.

Exclusion criteria

- Concomitant infections processes related or unrelated to surgical procedure contemplated
- Gross contamination of operative site at the time of surgery
- Surgical procedures of oral cavity, anal, perianal area were considered contaminated
- Diabetes, steroid therapy, renal impairment, leukocytosis, and other factors predisposing
- The patient to infection
- Those administered systemic antibiotics within a week before surgery
- Allergy to ceftriaxone
- Emergency surgical procedures were not included.

The selected patients were divided at random into two Groups: A and B, comprising 25 cases each. Informed consent was obtained from all the patients. Group A received the total three doses of ceftriaxone 1 g each intravenously. First dose 12 h before operation, second dose 1 h before operation and third dose was given 10 h after the operation. Thereafter, the antibiotic was withheld.

Group B received ceftriaxone B. D. intravenously postoperatively for 5 days [Table 1].

Operative and postoperative management was identical in both groups. Where drains were used they were brought out from a separate stab incision. Demographic characteristics such as age and sex were noted. Other variables such as nutritional status (body mass index [BMI]), co-morbid conditions such as anemia, type of anesthesia given, and use of drain were compared in two groups.

Follow-up was performed on the 3rd postoperative day, the 5th postoperative day [Table 1], on the day of stitch removal, and then on the 30th postoperative day. The severity of infection was graded as:

- Grade 0: No infection
- Grade 1: Minimal infection (redness about a stitch)

- Grade 2: Pustules about a stitch or minor infection of wound edges without separation with no systemic reaction
- Grade 3: Frank infection of relatively small portion of wound with purulent discharge and some systemic reaction
- Grade 4: Frank infection of a large portion of wound usually with systemic reaction.

These grades of severity of infection were as per the Robertson classification [Table 1].^[6]

Pus culture and sensitivity were done only in Grade 3 and 4 infections. Observation in Group A and B was compared and then conclusion regarding the efficacy of regimen was drawn accordingly.

Statistical analysis

All data were analyzed using SPSS IBM software (SPSS Inc., IBM). The values were expressed as mean ± standard deviation, range, and percentages. Student's *t*-test was used to compare the means and Chi-squared test was used to compare the data and $P < 0.05$ was considered statistically significant.

RESULTS

Age and sex distribution

Thirteen (52%) patients in Group A and 14 (56%) in Group B were of age < 40 years and rest were 40 years or more. The mean age of patients of Group A was 36.60 ± 10.47 , and in Group B, it was 37.44 ± 11.40 . The range of age was 21–60 years in Group A and 23–60 years in Group B [Table 1]. The difference in age between the two groups was not significant statistically ($P > 0.05$).

In Group A, 16 (64%) patients were females and 9 (36%) were males, whereas in Group B, 15 (60%) were females and rest 10 (40%) were males. The difference in sex incidence of the two groups was statistically insignificant ($P > 0.05$).

Incidence of postoperative wound infection

In Group A, one case developed postoperative wound infection and the incidence of postoperative wound infection in Group A patients was 4% in comparison to 24% in Group B patients in which six cases developed postoperative wound infection [Table 1]. The difference in the incidence of wound infection in Group A and Group B patients was statistically significant ($\chi^2 = 4.153$, $df = 1$, $P < 0.05$) [Table 2].

Grades of wound infection

In Group A one case (4%) developed Grade I wound infection, none of the case in Group A had Grade II, III or IV infection. Whereas in Group B, out of six cases who developed wound infection, two cases (8%) had

Table 1: Factors associated with postoperative wound infection

Factors	Group A		Group B	
	Number	Infected (%) of cases	Number	Infected (%) of cases
Age (years)				
<40	13	0	14	2 (14.29)
≥40	12	1 (8.33)	11	4 (36.36)
Gender				
Female	16	1 (6.25)	15	3 (20)
Male	9	0	10	3 (30)
Hemoglobin (gm%)				
<11	5	1 (20)	10	5 (50)
>11	20	0	15	1 (6.67)
Nutritional status (body mass index)				
Normal	15	0	15	0
Overweight	8	0	7	4 (57.14)
Underweight	2	1 (50)	3	2 (66.67)
Drain				
Used	5	1 (20)	8	4 (50)
Not used	20	0	17	2 (11.76)

Table 2: Incidence of postoperative wound infection

	Number of cases (%)	
	Group A	Group B
Wound infection		
Absent	24 (96)	19 (76)
Present	1 (4)	6 (24)
Grade of infection		
Grade I	1 (4)	2 (8)
Grade II	0	2 (8)
Grade III	0	2 (8)
Grade IV	0	0

Grade I, two cases (8%) had Grade II and two cases (8%) had Grade III infection. None of the cases in Group B had Grade IV infection. This difference in the incidence of different grades of wound infection in Group A and B was not statistically significant ($df = 3$, $\chi^2 = 4.915$, $P > 0.05$) [Table 2].

Statistical significance

No statistically significant relationship was found between type of procedure and occurrence of postoperative wound infections in both the groups.

Culture and sensitivity of wound discharge of infected patients

In Group A, culture and sensitivity were not performed since the infection encountered was of grade 1 only without discharge/pus. In Group B, one case (4%) was found to have growth of pseudomonas in the pus/wound discharge sent for culture/sensitivity and one case (4%) was found to have growth of *Staphylococcus aureus*. Both

the organisms were sensitive to piperacillin + tazobactam which was started as per schedule.

Other factors associated with postoperative wound infection

Age

In Group A, none of the patients below 40 years of age developed infection postoperatively, but 8.33% of cases in age group forty and above developed postoperative wound infections. The difference in incidence of postoperative wound infection between the two age groups in Group A was statistically not significant ($df = 1$, $\chi^2 = 1.129$, $P > 0.05$). In Group B, 14.29% of patients below 40 years and 36.36% of patients 40 years and above developed postoperative wound infection. This difference in the incidence of postoperative wound infection between the two age groups in Group B was not statistically significant ($df = 1$, $\chi^2 = 1.646$, $P > 0.05$).

Gender

In Group A, only one (6.25%) female but no male patient developed infection postoperatively. The difference in incidence of postoperative wound infection between the two genders in Group A was statistically not significant ($df = 1$, $\chi^2 = 0.586$, $P > 0.05$). In Group B, three (20.0%) female and three (30.0%) male patients developed postoperative wound infection. This difference in the incidence of postoperative wound infection between the two genders in Group B was not statistically significant ($df = 1$, $\chi^2 = 0.329$, $P > 0.05$).

Hemoglobin

None of the patient with preoperative hemoglobin (Hb) value above 11 gm% in Group A developed postoperative wound infection. In Group B, one (6.67%) case developed wound infection with Hb above 11 gm%. Whereas in patients with Hb level 11 gm% or less, one (20%) case in Group A and five (50%) cases in Group B developed postoperative wound infection. The difference of postoperative wound infection in patients with Hb level 11 gm% or less and those with Hb more than 11 gm% was statistically significant in both Group A ($df = 1$, $\chi^2 = 4.167$, $P < 0.05$) and Group B ($df = 1$, $\chi^2 = 6.177$, $P < 0.05$), showing that postoperative infections occur more frequently in patients with lower preoperative Hb value.

Nutritional status (body mass index)

In Group A, out of 2 patients who were underweight, one (50%) developed wound infection, and none patient in overweight group developed wound infection. In Group B, the rate of wound infection among patients with underweight and overweight nutritional status was 66.67% and 57.14%, respectively. These results showed that in Group A, wound infection was more common

in patients with underweight nutritional status and in Group B wound infection was more common in patients with underweight and overweight nutritional status. The difference of postoperative wound infection in different categories of nutritional status was statistically significant in both Group A ($df = 2$, $\chi^2 = 11.979$, $P < 0.05$) and Group B ($df = 2$, $\chi^2 = 11.947$, $P < 0.05$), showing significant statistically relationship between nutritional status and postoperative wound infection. Comparing the patients of overweight nutritional status, wound infection was statistically significant in Group B patients with respect to Group A patients ($P < 0.05$).

Use of drain

One (20%) case developed postoperative wound infection in Group A where drain was put and none developed wound infection where drain was not used. This indicated that wound infection was statistically significant ($df = 1$, $\chi^2 = 4.167$, $P < 0.05$) in cases where drain was put. Four (50%) patients developed postoperative wound infection in Group B where drain was used and two (11.76%) developed wound infection in cases where no drain was used. Again in this group wound infection was statistically significant ($df = 1$, $\chi^2 = 4.360$, $P < 0.05$) in cases where drain was used.

DISCUSSION

An effective prophylactic regimen should be directed against the most likely organisms. Infections can be prevented when effective concentrations of the drug are present in the blood and the tissue during and shortly after the procedure that is, during decisive period. Therefore, antibiotic prophylaxis should begin before the operation so that optimum drug concentration be there during decisive period. In spite of the use of prophylactic antibiotics, surgical site infections are still a risk of surgery and represent a substantial burden of disease in terms of morbidity, mortality and economic cost.

In our study, the overall infection rate was 4% in Group A and 24% in Group B which is comparable to other studies. In developing countries, the surgical site infection rate is much higher than Europe and the US. The incidence of surgical site infection in the reported developing countries is 11.5% in clean cases. The overall global incidence of surgical site infection is 0.4–30.9/100 surgical patients and 1.2–23.6/100 surgical procedures.^[8]

In our study, there was less incidence of wound infection in cases who received short course (three doses) of ceftriaxone sodium (Group A) as compared to those who received ceftriaxone sodium for 5 days (Group B). These results were statistically significant ($P < 0.05$). The lesser incidence of wound infection in the Group A might be due to lesser emergence of resistant strains of bacteria

and also because decisive period was covered with antibiotic coverage in short course regimen.

The present study shows statistically significant difference of in wound infection incidence between the two groups ($P < 0.05$) and higher grades of infection in Group B. Thus establishing the superiority of shorter, three dose decisive period covering antibiotic regime over the prolonged postoperative antibiotic use in concordance to Leuva *et al.* prolonged antibiotics administration are unnecessary and costlier. Three dose antibiotic regimen help in reducing the postoperative infection and hospital expenses.^[9]

In the present study, both the groups have statistically significant ($P < 0.05$) higher the infection rate where drain was used. The incidence of postoperative wound infection was higher (50%) in Group B than Group A (20%) where drain was used. Similar inference were reported by Lilani *et al.*,^[10] Mawalla *et al.*^[11] and Mundhada and Tenpe.^[12]

In our study, the relationship of Hb levels with the difference in infection rates found to be statistically significant in both groups, corroborating with Nwankwo^[13] and Rasouli *et al.*^[14] This is probably due to anemia resulting reduced oxygen saturation and tissue resistance at potentially infected sites with retarded wound healing in cases having lower Hb concentration.

In the present study, none of the patient with good nutrition (normal BMI) category developed postoperative wound infection in both the groups. These results showed that wound infection was more common in patients with underweight and overweight patients in Group B than Group A. The difference of postoperative wound infection in different categories of nutritional status was statistically significant in both Group A and Group B each ($P < 0.05$). Overweight patients wound infection was significant in Group B patients with respect to Group A ($P < 0.05$) establishing superiority of short course (three dose) ceftriaxone regimen. It may be the result of relative under microperfusion, subcutaneous adipose tissue ischemia, decreased antibiotics delivery, increased wound tension cum tissue pressure, and the oxygen availability to the wound.^[15-17] The difference in incidence of postoperative wound infection found to be not statistically significant ($P > 0.05$) with regard to age, gender and type of procedure in both groups.

Thus, from our study, it is seen that short course (three dose) antibiotic coverage which cover decisive period appears to be better than prolonged use of antibiotics in preventing postoperative wound infection. Furthermore, other factors such as low Hb concentration, use of

drain and poor nutritional status increase the risk of postoperative wound infection.

Thus with the appropriate and judicious use of antibiotics, we can reduce the cost and prolonged exposure to the unnecessary antibiotics which have its own side effects in addition to the contribution to the emergence of resistant microorganisms.

CONCLUSION

Short course (three doses) perioperative ceftriaxone prophylactic regimen is better than conventional prolonged postoperative use of antibiotics in controlling the postoperative wound infection. Decisive period antibiotic coverage is very important to prevent postoperative wound infections. The factors such as Hb, nutritional status, and use of drain all influence the rate of postoperative wound infection. It is therefore recommended that for decreasing the incidence of postoperative wound infections antibiotics should commence preoperatively to cover the decisive period along with the basic principles of surgery such as complete asepsis, gentle tissue handling, prevention of hematoma formation, avoidance of putting unnecessary drains, and clean sharp dissection. A short course (three dose) perioperative ceftriaxone prophylaxis covering the decisive period can be efficacious and cost-effective for prevention of wound postoperative infections. Appropriate and judicious use of antibiotics can reduce the cost, unnecessary antibiotic administration, side effects, and microbial resistance.

Limitation of study

The sample size was small. The large multicentric studies are required to substantiate the role of short-course antibiotic prophylaxis.

Suggestion

The large multicentric studies are required to be carried out regularly in each locality to establish any changes in the pattern of antibiotic resistance as well as spectrum of prevalent pathogens to substantiate the role of short-course antibiotic prophylaxis.

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Conflicts of interest

There are no conflicts of interest.

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