

Original Research Article

A comparative study of preoperative intra-incisional infiltration of ceftriaxone vs. intravenous ceftriaxone for prevention of surgical site infections

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ABSTRACT

Background: Surgical site infection (SSI) continues to be a major causes of post-operative morbidity, mortality since time immemorial. Many methods have been evolved to combat wound infection including concept of antisepsis and use of intravenous antibiotics. But the rate of SSI has been more or less static over the past few decades. The current study was undertaken to check effectiveness of preoperative intra-incisional infiltration of ceftriaxone for prevention of SSI.

Methods: This prospective study included 120 cases. Patients were randomly divided into two equal groups (60 each). Group A, considered control and received single dose of intravenous ceftriaxone (1 gm), whereas Group B, considered test and received intra-incisional ceftriaxone before starting procedure. If any evidence of SSI present, data recorded and swab sample was taken and sent for culture. Result of this analyzed for significance.

Results: In category A, 15 out of 60 patients (25%) developed SSI, while in category B, 3 out of 60 patients (5%) developed SSI. *Escherichia coli* is the commonest (72.22%) organism responsible for SSI in our study. Mean hospital stay of patients who develop SSI is nearly two times higher than who don't develop SSI.

Conclusions: This study confirms that the preoperative intra-incisional injection of ceftriaxone has resulted in a significant reduction in SSI infection rates in all classes of wounds both clinically as well as statistically (P value < 0.005).

Keywords: Surgical site infection, Ceftriaxone, Wound infection

INTRODUCTION

Surgical site infection (SSI) continues to be a distressing problem since time immemorial. Surgical site infection is defined as an infection that occurs at or near the surgical incision within 30 days after a surgical operation or within one year if an implant is left in place after procedure and affecting either incision or deep tissues.¹

Operations without surgical site infection remain an unfulfilled goal before the introduction of antisepsis by

Lister who made it a realistic objective. It was acceptance of Lister's work and the development of the aseptic antiseptic principles that allowed operative therapy to be successful and evaluation of modern surgery.²

SSI is one of the major causes of post-operative morbidity, mortality, increased hospital stay and treatment cost. Despite progress in their prevention, SSIs remain one of the most common adverse events in hospitals, Wound infection accounts for nearly one-fourth of the total number of nosocomial infections.³

Surgical site infection rate has varied from a low of 2.5% to a high of 41.9%.⁴ Incidence of SSI in India reported to vary from 3.6% to 22.5%.⁵

Sources of SSI dependent on type and location of the operation, as well as the wound type. Sources of SSI can include the patient's own normal flora of skin, organisms present in the hospital environment and in lower bowel surgery. The common organisms present in post-operative infected wound are *Staphylococcus aureus*, *Escherichia coli*, Coagulase-negative *Staphylococci*, *Enterococci*, *Proteus*, *Pseudomonas* and *Klebsiella* species.¹

Many methods have been evolved to combat wound infection during last century. Shortly after the introduction of the first antimicrobial agent Penicillin alone was shown to reduce the infection rate in abdominal surgery to 10% from a control rate of 25%.⁶

Initially, the antibiotics were only used post-operatively for treatment of already established SSI. Later, the concept of antibiotic prophylaxis was introduced. Many studies established the fact that preoperative prophylaxis with antibiotics reduces wound infection.⁷ Current practice is use of systemic administration of antibiotics before surgical incision. But the rate of SSI has been more or less static over the past few decades.

When any antibiotic is administered intravenously, it gets distributed initially in the systemic pool and then in the peripheral pool, which results in a low concentration of the antibiotic at the site of incision where it is needed the most.⁸ It is well recognized fact that the most important factor in the pathogenesis of surgical site infection is the presence of bacteria in the incision site at the time of closure. Therefore, search for an alternative mode for prevention of SSI is going on to further decrease in the SSI.

One of the methods is intra- incisional infiltration of antibiotics just prior to surgery. The concept of intra-incisional injection of antibiotics was introduced by Taylor in 1985.⁹ This mode ensures a high concentration of antibiotic at the incision site and it has been proven to provide systemic cover by the absorption of the antibiotic from the incision site. This is primarily because the antibiotic gets fixed to the tissues along the incision and thus the antibiotic is present in a high concentration during time of maximum contamination of incision site.¹⁰

Ceftriaxone is a long-acting third generation cephalosporin. Ceftriaxone has long elimination half-life of 5.8 to 8.7 hours. Ceftriaxone is rapidly and completely absorbed following intramuscular or intravenous administration.¹¹ Antimicrobial activity of ceftriaxone is very good against commonly found microorganism.¹²

Because of these facts ceftriaxone is widely accepted a prophylactic treatment schedule for surgical patients. It

was chosen for this study because of its range of activity and also because it was known to be suitable for subcutaneous and intramuscular use causing no reported local adverse side effects.

Even though after all measure complete elimination of surgical site infection is not possible, a reduction of the surgical site infection rate to a minimum level could have marked benefits in terms of both patient comfort and resources used.

The current study was undertaken to a comparison of preoperative intra-incisional infiltration of ceftriaxone vs. intravenous ceftriaxone for prevention of surgical site infections.

METHODS

This prospective study was conducted in the Department of General Surgery, Sardar Patel Medical College & P.B.M. Hospital, Bikaner, Rajasthan. 120 cases included in study that were operated in this hospital from September 2017 to August 2018. All cases of clean, clean contaminated and contaminated included. Patients were randomly divided into two equal groups (60 each) and operated by same surgical unit. The patient aged between 15 to 60 years included in this study. The study was approved by the Institutional Ethical Committee. Exclusion criteria includes dirty case, operative procedure that last for more than 3 hours, diabetes mellitus, pregnancy, bleeding disorders, immunocompromised patients, HIV, HCV, HBsAg positive cases, history of receiving systemic antibiotics within 2 weeks of proposed surgery, patients undergoing surgery with surgical site infection of previous operative procedure and presence of local infection.

Cases included in this study are Clean (open inguinal hernioplasty, Thyroidectomy, palomo's procedure and splenectomy), clean contaminated (open cholecystectomy, interval appendectomy, gastrojejunostomy and right hemicolectomy) and contaminated (peptic perforation, enteric perforation and appendicular perforation).

Patients randomized into two groups of 60 each. Group A, considered control and received single dose of intravenous ceftriaxone (1 gm), whereas Group B, considered test and received intra-incisional ceftriaxone.

One day prior to the surgery, test dose of antibiotic given intra-dermally to exclude hypersensitivity reactions.

Surrounding area of proposed surgical incision shaved and cleaned with soap and water in the morning before the surgery. In operation theatre, after induction of anesthesia, the part painted with povidone iodine followed by methylated spirit and dried up. Then the diluted antibiotic infiltrated along the proposed incision site 10 min before the starting of surgery.

The dose of antibiotic used for infiltration is 1 gram of ceftriaxone dissolved in 10 ml of distilled water and it infiltrated uniformly 1 cm circumferentially around all the margins of the planned incision with a disposable syringe and in subcutaneous tissue plane (Figure 1). After completion of surgery wound is categorized in one of three categories. Then operation site covered with sterile gauze and covered with adhesive bandages.

First dressing done after 48 hours, when first inspection of the suture site carried out. After that surgical site inspected on alternate day for wound infection if patient not develop SSI and discharged than patient followed up in General Surgery OPD (Figure 2 and 3).

Ceftriaxone of same brand used throughout the study. Patients in both groups received routine post-operative antibiotics covering gram positive, gram negative and anaerobes according to surgery. However, patients who developed signs of infection antibiotic changed according to culture sensitivity report of pus.

After discharge from hospital all cases [infected or not] followed up in the OPD at weekly intervals for 1 month. The data collected in the form of how many patients develop wound infection in each group. And what organism identified from infected wound.

Data analyzed using the Statistical Program for Social Sciences (SPSS 10.0 for Windows) package. The

statistical methods used to compare the two data were the chi square test and the independent sample t test. P value <0.01= highly significant, <0.05= significant, >0.05= not significant.

RESULTS

Total of 120 cases were enrolled for this study, out of which 18 patients were found to have SSI. Overall incidence in our study was 15%. No increased operative problems resulted from the ceftriaxone injection, although increased vascularity was noted in some patients at the site of injection at the time of the initial incision. This local bleeding settled rapidly and resulted in no increase total blood loss. No adverse reactions were noted either local or systematically from the use of intra-incisional ceftriaxone.

Maximum number of patients (46) lies in age group of 46-60 years in study. Maximum incidence of SSI (20%) was seen in age group of 31-45 years. Minimum number of cases of SSI is seen in 15-30 year age group (9.09%). These values are clinically significant but χ^2 value is 1.9995 and P value is 0.3679 which is not statistically significant ($p>0.05$). Mean age in study group was 39.65 ± 1.35 years. 86 male patients and 34 female patients included in study. In our study incidence of SSI is not attributed to age or sex.

Table 1: Distribution of SSI according to category.

Category	Total Cases	Number of patients developed SSI	Percentage	χ^2	P value
A	60	15	25%	9.4118	0.0021
B	60	3	5%		
Total	120	18	15%		

Table 2: Incidence of SSI according to wound class.

Group	Category A		Category B		χ^2	P value
	SSI/total	%	SSI/total	%		
Clean	2/17	11.76	0/19	0	NA	NA
Clean contaminated	5/22	22.72	1/20	5	2.6886	0.101
Contaminated	8/21	36.36	2/21	9.52	4.725	0.029
Total	15/60	25	3/60	5		

Table 3: Mean hospital stay (days) of cases in relation to complications.

SSI	No. of Cases	Mean hospital duration (days)	SD	T	P value
No	102	5.42	0.33	37.84	0.0001
Yes	18	12.66	1.8		
Total	120	6.49	0.45		

In category A, 15 out of 60 patients (25%) developed SSI, while in category B, 3 out of 60 patients (5%) developed SSI. These data shows that SSI is reduced significantly both clinically and statistically in category B (Table 1).

In clean cases of category A, 2 out of 17 patients (11.76%) developed SSI, while in category B, SSI was not seen. SSI is significantly reduced in clean cases but statistical analysis is not applicable because of zero value in one category (Table 2, Figure 4).

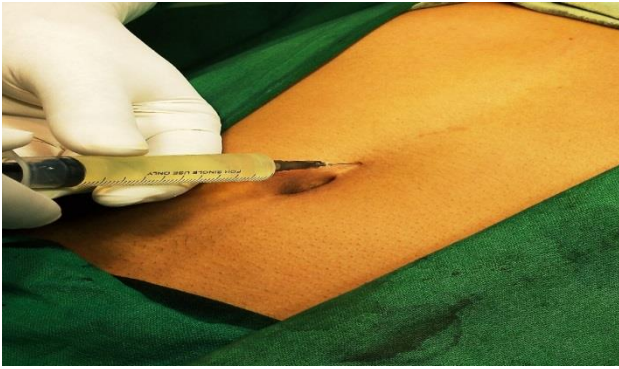


Figure 1: infiltration of antibiotic at incision site after painting and draping.



Figure 3: Surgical site infection on post-operative day 7 in a category A patient.



Figure 2: Well healed suture line in a category B patient.

In clean contaminated cases in category A, 5 out of 22 patients (22.72%), while in category B, 1 out of 20 patients (5%) developed SSI. On applying χ^2 test χ^2 value is 2.6886 and P value is 0.101 (>0.05) conclude that difference is not statistically significant (Table 2).

In contaminated cases in category A, 8 out of 21 patients (36.36%) developed SSI, while in category B, 2 out of 21 patients (9.52%) developed SSI. χ^2 value is 4.725 and p value is significant (0.029).

Most of the SSI noted on 7th post-operative day (50%). SSI earliest noted on 5th post-operative day.

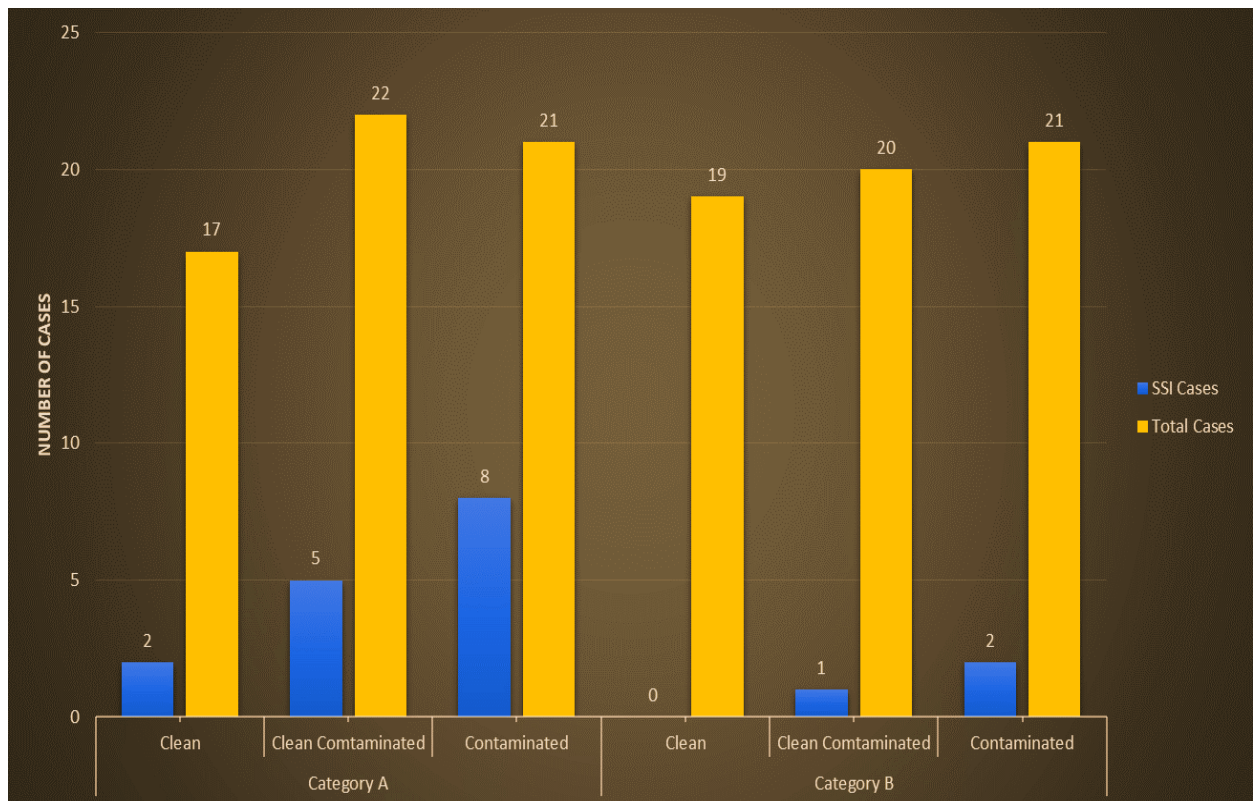


Figure 4: Incidence of SSI according to wound class.

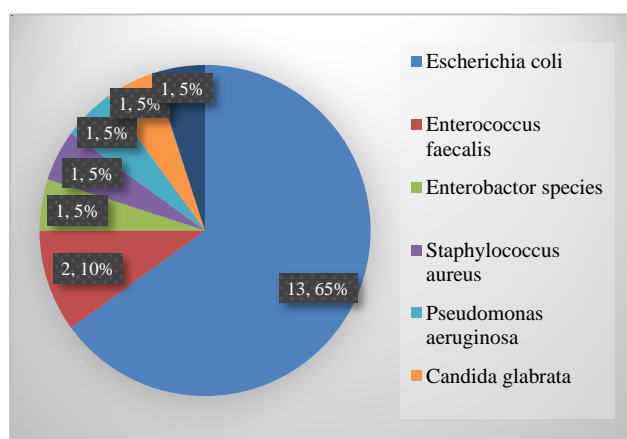


Figure 5: organism identified from pus obtained from surgical site.

Mean hospital stay of patients who develop SSI is higher. Mean hospital stay of patient who didn't develop SSI is 5.42 days, while 12.66 days for who develop SSI. Here p value is highly significant (<0.05) (Table 3).

Escherichia coli is the commonest organism responsible for SSI in our study. *E.coli* is responsible for 72.22% of SSI. Other bacteria identified from surgical sites are *Enterococcus faecalis*, *Enterobacter* species, *Staphylococcus aureus*, *Pseudomonas aeruginosa*, *Klebsiella* species.

All though most of the cases were infected with bacteria however, fungus *Candida glabrata* was also identified from one case (Figure 5).

DISCUSSION

Surgical site infection is an inevitable complication of any surgery. SSI increases both hospital stay and cost of surgery. In the era of laparoscopy and robotics, SSI have reduced to very low levels but they still remain a major cause of postoperative morbidity in open procedures. Many methods to prevent SSI have been evolved since discovery of asepsis.

We do surgical prophylaxis to achieve and maintain a good tissue concentration of a drug during the period of surgery, where potential bacterial contamination of the wound occurs. By this method those organisms introduced into the wound during surgery would be destroyed immediately. Intravenous administration of drug fails to maintain adequate serum and tissue levels throughout the surgical procedure and increases the likelihood of infection. It has also been postulated that wound levels of antibiotics, not blood or serum levels, appear to determine the efficacy of agents for prophylaxis of SSI. These very high tissue levels can only be achieved by a preoperative intra-incisional injection of antibiotics.

Present study shows in category A, 15 out of 60 patients (25%) developed SSI, while in category B, 3 out of 60 patients (5%) developed SSI. Overall rate of SSI in Group B (test) were found to be nearly five times lower than Group A (Control) and that was statistically significant with p value of 0.0021. These data shows that SSI is reduced significantly both clinically and statistically in category B.

A similar study carried out by Taylor et al study in 1982 A consecutive series of 181 patients undergoing abdominal surgery were included.⁹ In this study, they noticed SSI in 15 out of 90 patients (16.60%) in category A and 4 out of 91 patients (4.39%) in category B. P value was 0.007 which is significant.

In 1989, another similar was study carried out by Pollock et al, where, a total of 624 consecutive eligible patients undergoing abdominal operations included.¹⁵ They used a single preoperative dose of amoxicillin/clavulanic acid (1.2 g Augmentin) instead of ceftriaxone for the prophylaxis of surgical wound infection. They found 15.9% rate of SSI in patients those received intravenous antibiotics and 8.4% in intra-incision group. P value for this study was significant (0.005).

Another similar study carried out by Bharat Bhushan Dogra et al. They found that four out of 40 (10%) patients in intra-incision group and seven out of 40 (18%) in intravenous group developed SSI. However on statistical analysis, the difference between was not significant but incidence of SSI was less in intra-incision group.

After reviewing these valuable literature it is concluded that pre-incisional intra-parietal injection is more effective than intravenous injection of antibiotics for the prophylaxis of surgical wound infection.

On comparison of SSI according to type of wound, in clean cases rate of SSI is very low. Many studies recommended no significant benefit of antibiotics prophylaxis. We found in our study of clean cases that in category A, 11.76% patients developed SSI, while in category B, SSI was not seen. These findings are clinically significant but statistical analysis was not possible because of zero value in one group. This factor analysed in study by Anand et al showed that wound infection was higher in category A (25%) as compared to category B, where it was nil.¹⁵ These findings are consistent with our study.

In clean contaminated case Anand et al^[15] found that 12.9% cases developed SSI in category A and zero cases in category B.

Another similar study carried out by Patil et al.¹⁶ They studied clean contaminated cases of appendectomy. Another variation in there study was they used cefotaxime instead of ceftriaxone. They found that 3.3% patients from intra-incision Group and 13.3% patients

from intravenous group were documented as having superficial surgical site infection. In conclusion of their study they noted although not statistically significant, there was clinically a lesser incidence of SSI in individuals who received intra incisional antibiotic.

In contrast, in our study we found higher wound infection. In category A, rate of SSI is 22.77% and in category B, rate of SSI is 5%. The difference is clinically significant but statically not significant.

Statistical and clinical significant difference were noted in contaminated cases. In our study, we noted an incidence of SSI of 36.36% in category A, while in category B, the incidence was 9.52%. P value is significant (0.029). In study carried out by Samir Anand et al^[15] SSI in category A is nearly similar to our study (36.66%). While in category B they noted higher surgical site infection than our study (20.83%). It was still a significant difference in incidence of SSI in both categories.

Another study carried out by Sudhir S. et al^[17]. They studied 50 cases of exploratory laparotomy for perforation peritonitis in there study. The incidence of SSI in the group which received subcutaneous infiltration of antibiotic was less than the group of patients, which did not receive ceftriaxone.

In Western countries, overall rate of SSI is less. Large studies were conducted by Horen et al^[18] with 60,000 patients as a sample size. Studies reported infection rate of clean cases as 1.5-3.7%, clean and contaminated as 3-4%, contaminated wounds as 8.5%.

However, in the developing countries like India the rate are much higher.

A study in a teaching hospital of Goa carried out by Umesh S. Kamat et al^[19] showed infection rate of 30.7%. They included 114 cases in study and found that rate of SSI is 5.4% for clean, 35.5% for clean-contaminated, and 77.8% for contaminated operation.

Another study carried out by Mahesh C B et al^[20] noticed the overall infection rate was 20.09%. The SSI rate was 11.53% in clean surgeries, 23.33% in clean contaminated ones, 38.10% in contaminated surgeries.

This difference of the rate of SSI in Indian study group and in developed countries is probably due to poor nutritional status, increased incidence of infective disease and operating environment in Indian population. Also India being a tropical country, has higher temperature and humidity also favours SSI.

In our study conducted in north western Rajasthan, the incidence of SSI was 5.58% in clean case, 14.28% in clean contaminated cases and 23.8% in contaminated cases. Although higher than studies conducted in

developed countries, our incidence was significantly lower than other Indian studies possibly due to a dry climate of Rajasthan.

Our study shows that most of the SSI noted on 7th post-operative day (50%). SSI earliest noted on 5th post-operative day. It warrants a careful inspection of surgical site on 5th and subsequent postoperative days. If any sign of SSI appears one or two sutures should be removed and collected pus should be drained and sent for culture and antibiotic sensitivity.

The organisms identified from surgical site varies from hospital to hospital and surgery to surgery. Study carried out by Kamat et al noticed that pseudomonas (40%) is most commonly identified organism from surgical site.¹⁹ Other organism identified were *Staph pyogenes* (34.20%), *Klebsiella* (22.85%) *E. coli* (20%).

In our study we found that *E. coli* is most common organism isolated from surgical site. *E.coli* is accounts for 72.22% of SSI. Other bacteria identified from surgical sites are *E. faecalis* (11.11%), *E. species* (5.55%), *S. aureus* (5.55%), *P. aeruginosa* (5.55%), *Klebseilla species* (5.55%).

Although most of the cases were infected with bacteria however, fungus *C. glabrata* (5.55%) was also identified from one case.

We found that length of hospitalization (from date of operation to date of discharge) is prolonged due to SSI. Mean hospital stay of patient who didn't develop SSI is 5.42±0.33 days, while 12.15±12.66 days for who develop SSI. Here p value is <0.05 suggestive of hospital stay was significantly increased due to SSI.

It is noteworthy that not all infected patients were diagnosed before their discharge from hospital; these patients may not have had the same access to treatment, and infection may consequently have caused more distress than for patients who were diagnosed in hospital. Infections not detected in hospital may also resulted in an underreporting of SSIs. But this factor is consistent with both categories in our study hence may not have altered the results of a comparative study.

CONCLUSION

Surgical site infection is very distressing problem. This study confirms that the preoperative intra-incisional injection of a broad spectrum antibiotic (ceftriaxone) has resulted in a significant reduction in SSI infection rates in all class of wounds. The higher concentration achieved at the incision site by the intra-incisional route theoretically makes it a better mode of administering prophylactic antibiotics. But, this fact can be better established in a larger randomized control trial where factors like concentration of the antibiotic in the blood and at

incisional site at various intervals, affinity of the antibiotic to adipose tissue are also studied.

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REFERENCES

1. Bajaj A, Kukanur S, Kotigadde S, Meundi M. Gram Positive Cocci Causing Surgical Site Infection: Identification and Antibiotic Susceptibility Pattern. *IOSR J Dental Med Sci.* 2015;1(14):62-7.
2. Garipey TP. The introduction and acceptance of Listerian antiseptics in the United States. *Journal of the history of medicine and allied sciences.* 1994;49(2):167-206.
3. Haley RW, Culver DH, White JW, Morgan WM, Emori TG. The nationwide nosocomial infection rate: a new need for vital statistics. *Am J Epidemiol.* 1985;121(2):159-67.
4. Lilani SP, Jangale N, Chowdhary A, Daver GB. Surgical site infection in clean and clean-contaminated cases. *Indian journal of medical microbiology.* 2005;23(4):249.
5. Jain A, Bhatawadekar S, Modak M. Bacteriological profile of surgical site infection from a tertiary care hospital, from western India. *IJAR.* 2014;4(1):397-400.
6. Westerman EL. Antibiotic prophylaxis in surgery: Historical background, rationale, and relationship to prospective payment. *American journal of infection control.* 1984;12(6):339-43.
7. Karlatti, Suresh, and I. B. Havannavar. A comparative prospective study of preoperative antibiotic prophylaxis in the prevention of surgical site infections. *Int Surg J.* 2016;3(1): 141-5.
8. Armstrong CP, Taylor TV, Reeves DS. Pre-incisional intraparietal injection of cephmandole: A new approach to wound infection prophylaxis. *Br J Surg.* 1982;69(8):459-60.
9. Taylor TV, Walker WS, Mason RC, Richmond J, Lee D. Preoperative intraparietal (intra-incisional) cefoxitin in abdominal surgery. *Br J Surg.* 1982;69(8):461-2.
10. Dogra BB, Kalyan S, Rana KV, Panchabhai S, Kharade K, Priyadarshi S. A study comparing preoperative intra-incisional antibiotic infiltration and prophylactic intravenous antibiotic administration for reducing surgical site infection. *Med J DY Patil Univ.* 2013;6:405-9.
11. Patel IH, Kaplan SA. Pharmacokinetic profile of ceftriaxone in man. *Am J Med.* 1984;77(4C):17-25.
12. Cleeland R, Squires E. Antimicrobial activity of ceftriaxone: a review. *Am J Med.* 1984;77(4C):3-11.
13. Pollock AV, Evans M, Smith GM. Preincisional intraparietal Augmentin in abdominal operations. *Annals of the Royal College of Surgeons of England.* 1989;71(2):97
14. Dogra BB, Kalyan S, Rana KV, Panchabhai S, Kharade K, Priyadarshi S. A study comparing preoperative intra-incisional antibiotic infiltration and prophylactic intravenous antibiotic administration for reducing surgical site infection. *Medical Journal of Dr. DY Patil University.* 2013;6(4):405.
15. Anand S, Batra R, Arora B, Atwal S, Dahiya RS. A comparative study of preoperative intra-incisional infiltration of ceftriaxone vs. intravenous ceftriaxone for prevention of surgical site infections in emergency cases. *J Evolution Med Dent Sci.* 2016;5(64):4537-41.
16. Patil AN, Uppin VM. Intra-incisional versus intravenous route of antibiotic administration in preventing surgical site infections: a randomized controlled trial. *International Surgery Journal.* 2018;5(4):1438-42
17. Sudhir S, Telkar KG. A study of the wound performance following subcutaneous infiltration and topical instillation of ceftriaxone before primary closure of skin in laparotomy for peritonitis due to non-traumatic perforation of small intestine. *International Surgery Journal.* 2017;4(12):3956-61.
18. Culver DH, Horan TC, Gaynes RP, Martone WJ, Jarvis WR, Emori TG, Banerjee SN, Edwards JR, Tolson JS, Henderson TS, Hughes JM. Surgical wound infection rates by wound class, operative procedure, and patient risk index. *The American journal of medicine.* 1991;91(3):S152-7.
19. Kamat US, Fereirra AM, Kulkarni MS, Motghare DD. A prospective study of surgical site infections in a teaching hospital in Goa. *Indian Journal of Surgery.* 2008;70(3):120.
20. Mahesh CB, Shivakumar S, Suresh BS, Chidanand SP, Vishwanath Y. A prospective study of surgical site infections in a teaching hospital. *J Clin Diagn Res.* 2010;4(5):3114-9.

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