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Original Research Article

An Experimental Study Comparing Preoperative Intraincisional Antibiotic Infiltration and Prophylactic Intravenous Antibiotic Administration for Reducing Surgical Site Infection in Laparotomy Surgeries

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Abstract

Background: The goal of surgical prophylaxis is to prevent wound infection and hence complications. Failure to maintain adequate serum and tissue levels throughout the surgical procedure increases the likelihood of the infection. Polk and Lopez-Mayor have emphasized that wound levels, not blood or serum levels, appear to determine the efficacy of agents for prophylaxis of operative wound infection. Intraincisional infiltration of the antibiotic of choice enables the maintenance of adequate minimum inhibitory concentration of the antibiotics at the wound site.

Materials and Methods: Patients undergoing laparotomy surgeries either in elective or emergency settings was classified into two groups, one receiving preoperative intraincisional ceftriaxone infiltration along with intravenous ceftriaxone administration and the other receiving intravenous ceftriaxone alone as prophylaxis. The wound is classified into clean-contaminated, contaminated and dirty and the outcomes of both groups were analysed in terms of superficial, deep and organ/space infection and complication. The drug concentration at the wound site and serum were measured simultaneously and documented.

Results: Among the 100 patients, 35 of them were cases for whom infiltration was done and 65 of them were controls. Postoperative infection was present in 22% of cases (8 patients) and 49.23% of controls (32 patients). 12% of infection was seen in elective surgery and 87.5% of infection following emergency surgery. Organ space SSI contributes to 72.42 % of complications and deep SSI to 54.54% and superficial SSI to 29.41% respectively. The presence of contaminants influenced the occurrence of infection and complications significantly. The most important contaminants were pus, faecal matter, gangrenous bowel and toxic fluid. Among the microorganisms that colonised the postoperative infection, staphylococcus accounted for the majority of cases (50%), followed by E. coli (31.57%) and Klebsiella (15.78%). The amount of drug present in incisional drain fluid at the end of 24 hours was observed to be well above the

MIC of most bacteria causing SSI in those who received infiltration while in controls, no drug was present at the incisional site by the end of 24 hours.
Conclusion: In our study, there was a significant reduction in the incidence of SSI in the group, which received both intraincisional and intravenous ceftriaxone preoperatively than the other group which received only intravenous ceftriaxone. Preoperative intraincisional antibiotics significantly reduced the rate of SSI because of the higher concentration achieved at the incision site.
Keywords: Preoperative Intraincisional Antibiotic Infiltration, Prophylactic Intravenous Antibiotic Administration, Surgical Site Infection, Laparotomy.

Background

Surgical site infections (SSIs) continue to be a significant problem for surgeons, which account for almost 40% of hospital-acquired infections. It increases the hospital stay thereby increasing the expenditure incurred by the patient and adding to the economic burden of the country.

SSIs usually occur 5 to 6 days postoperatively, 90% of which occur within 30 days after surgery. The goal of surgical prophylaxis is to ensure that a satisfactory tissue concentration of a drug with a reasonable spectrum activity against expected organisms is achieved and maintained during the period of potential bacterial contamination of the wound. So those organisms introduced into the wound during the operation would be destroyed immediately [1-4].

Failure to maintain adequate serum and tissue levels throughout the surgical procedure increases the likelihood of the infection. Polk and Lopez-Mayor, have emphasized that wound levels, not blood or serum levels, appear to determine the efficacy of agents for prophylaxis of operative wound infection. These very high tissue levels could be achieved by a preoperative intraincisional injection. So, to achieve high target tissue concentrations with effective antibiotics according to the microbiological prevalence of organisms in both clean-contaminated, contaminated and dirty surgical incisions is the need of the hour [5-6].

It is not advisable to use the antibiotics for a prolonged period, fearing the emergence of multi-drug resistant strains.

Aims and Objectives

1. To compare the efficacy of preoperative ceftriaxone infiltration at the incision site and intravenous antibiotic administration with that of intravenous ceftriaxone only in preventing surgical site infection in all laparotomy surgeries taken in elective and emergency manner and measuring the drug concentration in serum and incisional tissue drain fluid.
2. To compare the surgical site infection in two groups of patients, Group A - IV ceftriaxone + Local infiltration and Group B - IV ceftriaxone only.

Materials and Methods

Patients admitted to Govt. Rajaji hospital, Madurai from March 2016 to August 2016 for emergency or elective laparotomy surgeries were included with the consent obtained from the hospital ethical committee meeting conducted by the board members.

Inclusion Criteria

- All patients aged more than 13 years of both sexes undergoing laparotomy surgeries in Govt. Rajaji Hospital, Madurai.

- Patients not allergic to ceftriaxone test dose
- Patients consented to inclusion in the study according to designated proforma.
- All surgeries in which the GI tract is entered either as elective or emergency.
  - Clean-contaminated (Gastric surgery, Whipple)
  - Contaminated (Rectal surgeries)
  - Dirty (Perforative peritonitis, pyoperitoneum, blunt and stab injury abdomen)

Exclusion Criteria

- Patients allergic to ceftriaxone test dose
- Patients with jaundice
- Patients suffering from liver failure
- Clean cases where no GI tract was being entered
- Immunocompromised
- Patients on prolonged steroid therapy.
- Having diabetes mellitus
- Patients who did not give their consents for inclusion in the study according to the designated proforma

Study Procedure

All patients aged more than 13 years of both sexes were admitted to our GRH planning for laparotomy incision surgeries either in an emergency or elective setting with informed written consent. Patients were randomized into two groups by allotting random numbers.

Group A

Prophylaxis by both systemic and intraincisional infiltration of the antibiotic (1 gram of ceftriaxone was administered intravenously and 1 gram of ceftriaxone diluted with 10 ml of distilled water was infiltrated along the site of proposed incision 20 minutes before incision after induction by the anaesthetist).

Group B

A single dose of 1 gram of ceftriaxone was administered intravenously 20 minutes before the surgical incision at the time of induction of anaesthesia.

Results

Male: Female Ratio = 2.7: 1. Males were being operated on a higher number than females.

Table 1: Correlation between Infiltration, Infection and Complication

Infiltration vs. Infection					
		Infection			Total
		Absent	Present		
Infiltration	No	33	32		65
	Yes	27	8		35
Total		60	40		100
Infiltration vs. Infection Contingency Table					
Chi-Square Tests					
	Value	df	Asymp. Sig. (2-sided)	Exact Sig. (2-sided)	Exact Sig.(1-sided)
Pearson Chi-Square	6.593[a]	1	.010		
Continuity Correction	5.540	1	.019		
Likelihood Ratio	6.880	1	.009		
Fisher's Exact Test				.011	.008
Linear-by-Linear Association	6.527	1	.011		

N of Valid Cases	100				
a. 0 cells (.0%) have an expected count of less than 5. The minimum expected count is 14.00.					

Correlations

		Infiltration	Postop Infection	Complication
Infiltration	Pearson Correlation	1	-.257**	-.109
	SIG. (2-TAILED)		.010	.281
	N	100	100	100
Infection	Pearson Correlation	-.257**	1	.500**
	SIG. (2-TAILED)	.010		.000
	N	100	100	100
Complication	Pearson Correlation	-.109	.500**	1
	SIG. (2-TAILED)	.281	.000	
	N	100	100	100
**. Correlation is significant at the 0.01 level (2-tailed).				

There was a significant negative correlation between wound infiltration with antibiotics and postop wound infection at the level of P=0.01. There was a significant positive correlation between postoperative infection and the occurrence of complications at the level of P=0.01.

Table 2: Type of Surgery vs. Infection

Controls		**Infection**		**Total**
		No Infection	**Infection**	
Surgery	Elective	18	8	26
	Emergency	15	24	39
Total		33	32	65
Pearson chi-square tests		Value	DF	ASYMP. Sig. (2-Sided)
Controls		5.909	1	.015
Cases		1.724	1	.189

There was a significant difference in infection rate between the elective and emergency surgeries (P =0.015, P < 0.05) in controls and no significant difference in cases.

Table 3: Type of Surgery vs. Complications

Controls		**Complications**		**Total**
		Nil	Present	
Surgery	Elective	25	1	26
	Emergency	27	12	39
Total		52	13	65
Cases		Complications		Total
		Nil	Present	
Elective		11	0	11
Emergency		20	4	24
Total		31	4	35
Pearson chi-square tests		Value	DF	ASYMP. Sig. (2-Sided)
Controls		7.067	1	.008
Cases		2.070	1	.150

There was a significant difference in complication rate between the elective and emergency surgeries (P = 0.008, P < 0.01) in controls and no significant difference in cases.

Table 4: Class of Wound vs. Infection

Controls		**Infection**		**Total**
		Nil	Present	
Class of Wound	Clean-contaminated	20	5	25
	Contaminated	2	3	5
	Dirty	11	24	35
Total		33	32	65
Cases		**Infection**		Total
		Nil	Present	
Class of Wound	Clean-contaminated	9	1	10
	Contaminated	4	1	5
	Dirty	14	6	20
Total		27	8	35
Pearson chi-square tests		VALUE	DF	ASYMP. Sig. (2-Sided)
Controls		14.017	2	.001
Cases		1.539	2	0.463

Class of Wound vs. Infection

There was a significant difference in infection rate depending on the class of wound (P =0.001, P < 0.01) in controls and no significant difference in cases.

Table 5: Class of Wound vs. Complication

Controls		**Complication**		**Total**
		Nil	Present	
Class of Wound	Clean-contaminated	23	2	25
	Contaminated	5	0	5
	Dirty	24	11	35
Total		**52**	**13**	**65**
Cases		**Complication**		Total
		Nil	Present	
Class of Wound	Clean-contaminated	10	0	10
	Contaminated	5	0	5
	Dirty	16	4	20
Total		31	4	35
Pearson chi-square tests		Value	DF	ASYMP. SIG. (2-Sided)
Controls		6.357	2	0.042
Cases		3.387	2	0.184

There was a significant difference in complication rate depending on the class of wound (P =0.042, P < 0.05) in controls and no significant difference in cases.

Table 6: Type of Infection vs. Complication

		Complication		Total
		Nil	Present	
Type of Infection	No Infection	59	1	60
	Superficial	17	5	22
	Deep	5	6	11
	Organ	2	5	7
Total		83	17	100
Pearson chi-square tests		Value	DF	ASYMP. Sig. (2-Sided)
Controls		36.196	3	.000

There was a very high significant difference between the type of infection and complication with P < 0.001. There was no significant difference in both groups between hours of surgery and the presence of infection. Among controls, the contaminants which significantly contributed to the occurrence of postoperative infection were pus (P=0.01), faecal contamination (P=0.05), and gangrenous bowel (P=0.05).

Among cases, the contaminant which significantly contributed to the occurrence of postoperative infection was pus alone (P=0.05). Hence infiltration at the wound site afforded significant protection against all of the contaminants except pus.

Among controls, the contaminants which significantly contributed to the occurrence of postoperative complications were toxic fluid (P=0.01), faecal contamination (P=0.05), and pus (P=0.05). Among cases, the contaminants which significantly contributed to the occurrence of post-op complications were ascites (P=0.01) pus (P=0.05), and toxic fluid (P=0.05).

Discussion

SSI is one of the commonest complications following surgery. It is the third most commonly reported nosocomial infection and accounts for 14-16% of all nosocomial infections. The risk of SSI has been described to be around 2.6% in all operations and SSI rates are likely to be greater than reported since all surgical wounds are contaminated by atmospheric bacteria but only a few develop a clinical infection. A study was carried out in Italy to find out the incidence of SSI in general surgery, where 3,066 surgical procedures were carried out in 2,972 patients and 154 (5%) of them developed SSI. It also affects 2.6% of patients undergoing thyroid surgery. Bickel studied 210 patients who underwent open surgery for acute appendicitis and reported SSI in 5.6% of cases. Velezquez studied 80 patients who underwent open cholecystectomy and found SSI in 11.25% of cases. SSI has been brought down considerably by employing various aseptic measures in addition to the use of prophylactic systemic antibiotics. However, the rate has been static over the past few decades. The drawbacks associated with the use of prophylactic systemic antibiotics have been a lesser concentration of antibiotics at the incision site, fibrin matrix formed at the incision site, and improper timing of administration of the antibiotics [7-10].

This prompted newer modes of administering prophylactic antibiotics, one of which is the intraincisional infiltration of the antibiotic to ensure a higher concentration of the antibiotic at the incision site.

Data from the National Nosocomial Infections Surveillance System reveals that the most common SSI pathogens are Staphylococcus aureus, Enterococcus, coagulase-negative Staphylococcus, Enterobacteriaceae, and Pseudomonas species [11-13].

In our study, we were able to find out that, among the 100 patients, 35 of them were cases for whom infiltration was done and 65 of them were controls.

- Among the infiltrated cases, postoperative infection was present in 22% of cases (8 patients).
- Infection was present in approximately 49.23% of cases (32 patients) who were controls.
- Among the infected cases, 12% of infection was seen in elective surgery and the remaining 87.5% of infection following emergency surgery.
- In controls, 25% of the infection occurred following elective surgery and 75% were infected following emergency surgery.
- Since most of the patients in our study were taken after emergency surgery, 54% of controls (35 patients) and 57.14% of cases (20 patients) were dirty wounds.
- Since most of them were dirty wounds, the incidence of wound infection was also high.
- Complication rates like wound dehiscence, wound infection, rectus dehiscence, and burst abdomen were observed in 20% of controls (26 patients) and 11.4% (4 patients) of cases.
- This increase in the rate of complication was also because of the increased incidence of the dirty wound.
- Although the duration of surgery has traditionally been inscribed as a component to cause infection, there was no significant risk observed in our study.
- There was a high significance between the type of infection and complication.
- Organ space SSI contributed to 72.42 % of complications and deep SSI to 54.54% and superficial SSI to 29.41% respectively.
- On comparing the type of contaminant & occurrence of postoperative infection among controls, the presence of pus was highly significant (correlation significant at the level of 0.01) followed by faecal contamination and presence of gangrenous bowel. Among cases, only pus was significant (correlation significant at the level of 0.05) in causing postoperative infection.
- On comparing the type of contaminant and occurrence of postoperative complications among controls, the presence of toxic fluid was highly significant (correlation significant at the level of 0.01) followed by faecal contamination and presence of pus. Among cases, pus, ascites and toxic fluid were significant. (Correlation significant at the level of 0.05) in causing postoperative infection.
- Among the microorganisms that colonised the postoperative infection, staphylococcus accounted for the majority of cases (50%), followed by E.coli (31.57%) and Klebsiella (15.78%).
- Among the complications, wound gaping and secondary suturing were needed for almost 90 % of the cases and burst abdomen and anastomotic leak constituted 5% each.

The absorbance pattern was equated in the Beer-Lamberts equation and the concentration of the drug present in the tissue fluid level was calculated separately for the cases and controls. The mean concentration of the drug estimated was tabulated separately for cases and controls.

In some cases, the highest concentration of the drug was found in the serum at the end of surgery. This could be explained by the subcutaneous infiltration of the antibiotic, which got absorbed systemically and caused the increased concentration of the antibiotic at the end of the surgery. But in controls, the antibiotic concentration steadily started to decline. The significant change was in drain antibiotic concentration immediately after surgery, which was around 10 times higher than the controls. Though in some cases, the mean antibiotic concentration was within the MIC of the most common organism causing SSI, Staphylococcus aureus, Escherichia coli, Haemophilus influenza, Neisseria gonorrhoeae, Streptococcus pneumonia, there was no drug present at the drain site in controls, thereby paving the way for wound infection and its complications.

The concentration of antibiotics in this study adds to the scientific impact behind infiltration, that a high incisional tissue level of antibiotics for the first day prevents postoperative infection in a significant manner [14-15].

Conclusion

In our study, there was a significant reduction in the incidence of SSI in the group, which received both intraincisional and intravenous ceftriaxone preoperatively than the other group which received only intravenous ceftriaxone. Preoperative intraincisional antibiotics significantly reduced the rate of SSI because of the higher concentration achieved at the incision site.

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