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Comparison of the Preventive Efficacy of Topical and Injectable Meropenem versus Cefotaxime in Preventing Wound Infection in Umbilical Hernia Repair

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ABSTRACT

Background and Objective: Wound infection remains a troublesome problem that may complicate any surgical procedure. Prophylactic antibiotics are an important measure in reducing the rate of wound infection. The aim of this study was to evaluate and compare the efficacy of two different antibiotics (meropenem and cefotaxime) and different administration methods in preventing wound infection after umbilical hernia repair.

Methods: This cross-sectional study was conducted on 321 patients who underwent umbilical hernia repair by primary closure or mesh repair. A prophylactic antibiotic was used in all patients. They were divided into three groups depending on the type of antibiotic used and the method of administration. Group I received a single intravenous dose of cefotaxime before the procedure. Group II received one dose of intravenous cefotaxime preoperatively and another dose of cefotaxime injected locally at the operative site, and Group III received one dose of intravenous meropenem preoperatively plus another dose of local injection. All patients were monitored for evidence of wound infection for 30 days.

Findings: Of the 321 patients studied, 243 were female and 78 were male. The overall wound infection rate was 7.7%. Group III (meropenem used) had the lowest wound infection rate (0.9%) and was significantly different from the other groups (15% in Group I and 7.5% in Group II) ($p<0.05$). Also, the length of stay in Group III (2.2 days) was shorter than Group II (1.5 days) and Group III (one day).

Conclusion: The results of the study showed that topical and systemic administration of antibiotics effectively reduces the risk of wound infection. However, combined topical and systemic administration of meropenem provides the best result in controlling wound infection.

Keywords: *Umbilical Hernia, Infection, Antibiotics.*

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Introduction

Wound infection, or the "surgical site infection" as described in surgical textbooks, is one of the common complications of wounds in open surgery. It imposes significant discomfort on patients and the surgeons. Wound infection has consequences that range from simple to serious morbidities that may end with death (1). Furthermore, wound infection causes a significant burden to the health care system and an additional cost.

Many risk factors have been recognized which play various roles in the development of wound infection, including co-morbidities, length of surgical operation, type of wound, surgical site contamination, extremes of age, metabolic disorders, malnutrition, cancer, immunosuppression, tobacco smoking, presence of other infectious focus, emergency operations, and prolonged hospitalization before the surgery (2).

Wound infection is a frequent complication of open periumbilical hernia repair (3-5). A number of pre- and post-operative measures have been suggested to reduce the risk of wound infection. Judicious use of antibiotics is essential in lowering the wound infection (2). In hernia surgery, the prophylactic antibiotics play their role in controlling the wound infection (6). Types and methods of administration of antibiotics have different effects on the reduction of wound infection rate (7). This study reports our experience using two different prophylactic antibiotics in umbilical and paraumbilical hernia surgery with different administration methods to reduce the risk of wound infection.

Methods

This prospective randomized study was carried out in Al-Sader Teaching Hospital in Misan province within a period of about five years, from January 2018 to December 2022. A total of 321 patients with umbilical and paraumbilical hernias were enrolled (243 females and 78 males), and their ages ranged from 16 to 76.

"Ethical approval: The study was conducted under the ethical principles that have their origin in the Declaration of Helsinki. It was carried out with the patient's verbal and analytical approval before a sample was taken. The study protocol, subject information, and consent form were reviewed and approved by local ethics committee according to document number 5902 on February 19, 2023, to get this approval."

All our patients (with umbilical and paraumbilical hernia) were diagnosed depending on clinical history, physical examination, and abdominal ultrasound. The inclusion criteria: all the patients undergoing umbilical and paraumbilical surgery that fit for surgery referred to our hospital. The exclusion criteria were the emergency cases (strangulation and obstruction and patients that were allergic to cefotaxime or meropenem). Open surgical hernia repair was planned for all of our patients. The patients were allocated into three equal groups:

Group I: included 107 patients (81 females and 26 males) who received single pre-operative dose of IV cefotaxime

Group II: included 107 patients (81 females and 26 males) who received single pre-operative dose of IV cefotaxime (500 mg) + intraoperative instillation of (500 mg) of cefotaxime.

Group III: 107 patients (81 females and 26 males) received single pre-operative dose of meropenem (500 mg) + intraoperative instillation of 500 mg of meropenem

The reason of using the two selected antibiotics (meropenem and cefotaxime) in the study is that both are broad spectrum antibiotics and both have activity against Gram-positive and Gram-negative bacteria and most surgeons chose these antibiotics in necessary cases. Meropenem is a new carbapenem antibiotic and the cefotaxime is a third-generation cephalosporin.

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All preoperative intravenous antibiotics were given at time of induction of anesthesia. The average dose was 500 mg administered by intravenous route and 500 mg for topical instillation of each antibiotic.

The hernias were repaired by Mayo's primary repair or by nylon mesh. All cases were managed as one day case surgery. All patients were followed up at intervals over 30 days postoperatively for evidence of wound infection. The data was analyzed by chi-squared test, and p value≤0.05 was considered statistically significant.

Results

Majority of our patients are in young and middle age groups (274 out of 321 patients). Female patients with umbilical and paraumbilical hernia were about three times the male patients. The distribution of the patients according to sex and age is represented in Table 1.

Table 1. The distribution of patients by sex and age

Age of the patients (years)	Males	Females	Total
15-20	1	3	4
20-40	25	99	124
40-60	38	112	150
>60	14	29	43
Total, number(%)	78(24.3)	243(75.7)	321

About 38% of the patients were treated by primary repair and 62% by mesh repair, and the average hospital stay for group I was 2.2 days, group II was 1.5 days, and group III was 1.0 days (Table 2).

Table 2. Types of surgical repair and hospital stay

Group	Primary repair	Mesh repair	Average hospital stay (Day)
Group I	41	66	2.2
Group II	41	66	1.5
Group III	41	66	1.0
Total	123 (≈38%)	198 (≈62%)	

The patients were followed up for 30 days for evidence of wound infection, and the total wound infection rate in our series is about 7.7% and the highest rate is in group I (15%) and the lowest in group III (0.9%). The study also shows that the patients that were treated by mesh repair have higher wound infection rate in comparison with those treated by primary repair (16% Vs 9%) as it is shown in Table 3.

Table 3. Wound infection rate

Group	No. of patients with wound infection		Total	≈%	Type of repair		p-value
	Males	females			Primary	Mesh	
Group I	3	13	16	15	6	10	0.0006
Group II	2	6	8	7.5	3	5	0.0006
Group III	-	1	1	0.9	-	1	0.0006
Total, number(%)	5	20	25	7.7	9(7.3)	16(8)	0.0006

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Discussion

Our study revealed the effectiveness of prophylactic topical and systemic antibiotics in reducing the wound infection in comparison with systemic route. Wound infection rate was 0.9% in group III (combined topical and systemic meropenem group), 7.5% in group II (combined topical and systemic cefotaxime) in comparison with group I (intravenous cefotaxime group) which was 15% and these differences are statistically significant. In addition, it revealed that the choice of the type of antibiotic has a significant effect on reducing the wound infection rate (group III with meropenem has lower infection rate than group II that used cefotaxime). Stringel et al. in their study recorded that "topical antibiotic and a combination (topical/systemic) antibiotic were significantly more effective than systemic antibiotic alone in preventing wound infection"(7). The prophylactic topical antibiotics will produce high concentration of antibiotics at the surgical site and this will lead to reduced risk of wound infection. On the contrary, Chen et al. in their systematic review and meta-analysis revealed that "the routine application of topical antibiotics to surgical wounds did not reduce the incidence of surgical site infection" and they suggested further study regarding this subject (8). Generally, antibiotic prophylaxis is a strong weapon in the hands of surgeons to reduce the risk of wound infection with surgical operations, and the reduction may reach 60% (9). Umbilical and paraumbilical hernias are common surgical problems and constitute about 3%-8.5% of abdominal hernias (10). Well-recognized etiological factors for these hernias include endogenous factors like age, sex, and genetics and exogenous factors that generally lead to increased intra-abdominal pressure and weakness of the abdominal wall, including tumors, ascites, pregnancy, smoking, etc. (10, 11).

Studies have generally shown that umbilical and paraumbilical hernias are more common in females than in males (12), and this was the case in our study, in which the female-to-male ratio was 75.7% vs. 24.3%. Although a large number of patients with umbilical and paraumbilical hernias are asymptomatic, about 45% will develop symptoms like abdominal pain, nausea, and vomiting (13). These hernias tend to develop complications like ulceration, irreducibility, obstruction, and strangulation (14).

Mayo's primary repair and prosthetic mesh repair are the usual operations used in open surgery, with an increasing tendency toward mesh repair (15, 16). In our study, the surgical repairs of umbilical and paraumbilical hernia were by open Mayo's repair (40%) and open mesh repair (60%).

The postoperative complications of umbilical and paraumbilical hernias repair may include pain, seroma-hematoma collection, wound infection, iatrogenic bowel injury, ileus, and recurrence. Wound infection is the complication that "needs to be cared for the most" (11). Cruse et al., in their study "The epidemiology of wound infection' that was carried out in Foothills Hospital, have classified the surgical wounds into four classes and recorded the risk of wound infection in each one (clean wounds about 1.5%; clean contaminated wounds about 7.7%; contaminated wounds about 15.2%; and dirty wounds> 40%) (17). Even though umbilical and paraumbilical hernias are considered a clean surgery and the wound infection rate should be less than 1.5%, higher infection rates were recorded in many series, as it was 19% in Birindelli et al., 11% (18) in Kaufmann et al (19), 8.8% in Akhtar et al (11), and (7.5%) in Habib et al. (20) studies. Our study, total wound infection rate was 7.7%, which is almost in accordance with the studies above. In our study, the wound infection rate was slightly higher in patients that had mesh repair compared to Mayo's repair (8% vs 7.3), and this may be explained by the fact that the abdominal wall implant increases the wound surgical complications (21). Several series have studied the benefits of using prophylactic antibiotics with hernia surgery, such as Yerdel et al (22), Celdrán et al (23), and Lazorthes et al (24) studies which recommended the use of prophylactic antibiotics in hernia surgery as they lead to a significant reduction in wound infection rate. In contrast, Tzovaras et al (25), Shankar et al (26), and Ergul et al (27) showed the inefficacy of antibiotics in hernia surgery. In their study about surgical wound infection, Haley et al. noted: "although complete eradication of the wound infection is impossible, every effort should be taken to reduce the wound

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infection rate to the minimum which will be reflected with beneficial effects on the patients and health system resources" (28). In our series, the average hospital stay was lowest in the third group (one day), and was considered as one day-case surgery. All three groups of our patients in the present study have a lower hospital stay in comparison with other studies including that of Purushotham et al. (29), who reported seven days and 15 days in wound infection patients, and Abdel-Baki et al. (30) reported (3±1.6 days) for prosthetic mesh repair group and (3.5±2.2 days) for primary tissue repair group. The results of our study prove the beneficial use of combined topical and parenteral prophylactic meropenem in umbilical and paraumbilical hernia surgery to reduce the risk of wound infection. Based on the results of this study, prophylactic antibiotics are generally effective in reducing the risk of wound infection with surgical operations and the combined topical and systemic meropenem was the most effective in lowering the risk of wound infection. Also, the use of prophylactic antibiotics with surgery is associated with lower hospital stays.

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