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Original Article

Comparing the effectiveness of oral versus intravenous antibiotics in the prophylaxis of wound infection in hand laceration

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Abstract

Objective: Hand lacerations are among the most frequent causes of visiting emergency departments (EDs). Wound infection is one of its complications. There is still an ongoing disagreement on the administration of oral versus intravenous (IV) antibiotics (ABs). The objective of this study is to compare the effectiveness of oral versus IV ABs in preventing wound infection of hand lacerations.

Methods: In this double-blind, randomized clinical trial, we enrolled all patients with hand lacerations (based on the inclusion criteria) during 6 months in the EDs of 2 tertiary referral centers. Convenient sampling was done. Finally, in the first group, 382 patients received oral AB (two 500 mg cephalexin capsules) and the other 382 patients in the second group received IV AB (1 gr IV cefazolin) before wound management. Both groups were followed and received oral cephalexin during 48 hours after suturing. Rates of wound infection and different complications were compared between the two groups. T-test, Mann-Whitney U test, Chi square and Fisher analysis were used.

Results: Both groups had the same age and gender distribution rate (79.8% of males with the mean age of 30.8 years in the first group, and 83.5% of males with the mean age of 32.6 years in the second group ($P=0.19$ and 0.39, respectively). In our study, wound infection developed in 2.6% and 1.8% of patients in the first and second groups, respectively ($P=0.46$).

Conclusion: Based on the results of this study, oral and IV ABs were not significantly different in terms of preventing wound infection.

Keywords: Hand laceration, Oral antibiotic, Intravenous antibiotic, Wound infection

Introduction

Hand laceration is a quite common reason of all emergency department (ED) visits (1). Correct wound management is an essential part of emergency physician (EP) duties.

In the United States, hand laceration is seen more frequently in males and patients older than 18 years of age more possibly due to occupation injuries (2,3). Hand injuries are the second most common reason of absence from work (4). This can impose a great financial burden on the health system and a considerable risk of medicolegal issues (5).

In contrast to the considerable improvements made in foreign body removal, wound debridement and suturing techniques, antibiotic (AB) administration is still controversial and unconvincing (1). Prophylactic AB prescription in traumatic wound is one of the principles that have been emphasized in the previous studies (6).

The American College of Emergency Physicians recommended that in penetrating hand trauma, physicians should irrigate the wound with high pressure saline or surgical betadine solution, debride necrotic tissues and remove foreign bodies (7).

Some evidence in the literature shows that there is no statistically significant difference in the infection rate between patients receiving prophylactic AB and cases receiving none (8). Some studies have not recommended prophylactic AB use in hand laceration with low infection risk (9-12).

Worster et al classified wound severity and concluded treatment strategies. They revealed that in mild injuries (less than 2 cm cellulitis, superficial tissues involvement and no evidence of systemic illness) topical ABs could be used. In moderate injuries (more than 2 cm cellulitis, deep tissue abscess, deeper tissues involvement or evidence

of gangrene, immune competent patients) oral Abs are sufficient. In more severe injuries (acidosis, hyperglycemia and systemic involvement) IV Abs should be prescribed (13).

In this study, we decided to compare the effectiveness of IV versus oral AB in reduction of wound infection rate in hand lacerations.

Methods

In this double-blind, randomized clinical trial, we enrolled all patients with hand lacerations (based on the inclusion criteria) during 6 months in the EDs of 2 tertiary referral centers. Convenient sampling was done. Finally, in the first group, 382 patients received oral AB (two 500 mg cephalexin capsules) and the other 382 patients in the second group received IV AB (1 gr IV cefazolin) before wound management. Both groups were followed and received oral cephalexin during 48 hours after suturing. Rates of wound infection and different complications were compared between the two groups. T-test, Mann-Whitney U test, Chi square and Fisher analysis were used. All patients with hand laceration were enrolled in our study based on the inclusion criteria. The sampling was convenient and we used block randomization By considering the infection rate of 6% in hand laceration in IV AB groups, if this number increases to 11% in oral AB group, we will face a significant clinical change. Thus, we calculated a sample size of 382 cases in each group by considering a = 5% and Power = 80%. Our inclusion criteria were: age older than 18 years, signing the consent letter to participate in the study, having simple new lacerations (occurred within the last 24 hours) and needing repair by emergency physicians. Our exclusion criteria were: patients with crush laceration, very deep lacerations needing hand surgeon consults for repair (tendon, joint capsule or other deep structures involvement), having open fractures, animal or human bites, lacerations needing expertise consult or operation hall environment for repair, patients having allergies to cephalosporin and lacerations older than 24 hours. Consort flow diagram (V. 2010) is shown in Figure 1.

The treating emergency medicine (EM) resident diagnosed patients, performed the procedure, filled the questionnaire and followed patients for 5 months. Patients and EM residents were both blinded to the study. Only the triage nurse and chief investigator were aware of the codes for patients and the specific groups they were assigned to. Computerized block randomization was used and Subjects were randomly divided into two groups with block sizes of 4.

Patients were randomly divided into two groups before the procedure. In the first group, patients received oral cephalexin 2 capsules 500 mg and IV placebo. In the second group, IV cefazolin 1 gr and oral placebo were administered. After discharge, patients in both groups were followed and advised to take cephalexin capsule every 6 hours for the next 48 hours.

IV cefazolin vial is a white powder and when diluted with distilled water it has a colorless appearance. We used distilled water as its parallel placebo. We also administered an oral placebo exactly like cephalexin capsule provided by the same pharmaceutical company.

The specified drug and dose were provided and administered by the triage nurse based on the code. All patients were interviewed and the method of drug administration, and possible complications were explained to them and informed written consent was obtained.

The suture technique was the same for all patients (simple interrupted non-absorbable suture). Patients were followed and AB usage was precisely reminded to them. Sutures were removed 10-14 days after repair. The removal period was longer if the laceration was on the palm of the hands (14-21 days) (14). Wound complications like infection and dehiscence were checked and managed appropriately per case. Necessary expertise consults were obtained accordingly.

Our primary outcome was to compare the rate of wound infection between the two groups. Our secondary outcomes were comparing demographic data, time and mechanism of laceration as well as patients' satisfaction in both groups.

The data are presented as mean values or proportions, and differences in these values are presented with accompanying 95% confidence intervals (CIs). Variables were tested for normality (Kolmogorov–Smirnov test) before analysis. Analytical statistical tests included the unpaired, two-tailed *t* test for continuous normally distributed data and the Mann–Whitney U test for non-normal and ordinal data. The chi-square and Fisher's exact tests were used to compare proportions of the qualitative variables. The level of significance was 0.05. SPSS for Windows software (V.20) was used for all data analysis.

Results

We enrolled 871 patients in our study, 107 patients were excluded mostly because they had open fractures or bite wounds. There were 382 cases in each group. In oral AB group, we had 305 (79.8%) males and 77 (20.2%) females. In IV AB group, there were 319 (83.5%) males and 63 (16.5%) females. There was no significant difference between the two groups ($P = 0.19$).

The average age ranges were 30.8 ± 12.7 and 31.6 ± 12.3 years in oral and IV AB groups, respectively. There was not a statistically significant difference between the two groups ($P = 0.39$).

The mean time elapsed from injury was 1.9 ± 1.4 hours in oral and 2.0 ± 1.3 hours in IV AB groups. We did not see a significant difference ($P = 0.28$).

The mechanisms of injury in oral AB group were penetrating injury by sharp objects (knife or glass) (133

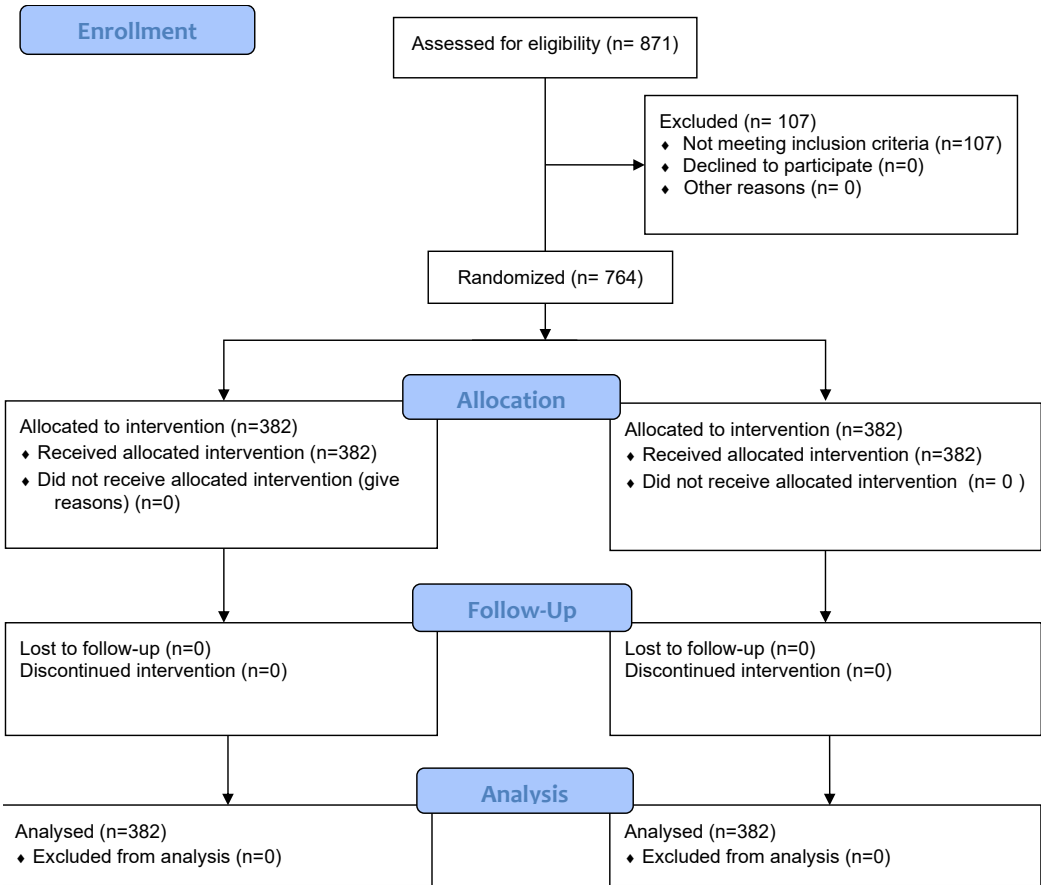

Figure 1. Flow diagram of our study

(34.8%) cases) and penetrating injury due to accidents (249 (65.2%) cases). The mechanisms of injury in IV AB group were penetrating injury by sharp objects (117 (30.6%) cases) and penetrating injury due to accidents (265 (69.4%) cases). *P* value was insignificant ($P = 0.22$). All lacerations overlying an open fracture were excluded.

Demographic data and other secondary outcomes are shown in Table 1.

Patients were satisfied with oral AB administration in 373 cases (97.6%) and they were also satisfied with IV AB administration in 376 cases (98.4%). This rate was the same between the two groups ($P = 0.87$).

Wound infection including laceration site discharge, erythema or edema or fever was observed in 10 patients (2.6%) in oral AB group and in 7 patients (1.8%) in IV AB group. This variable was also the same ($P = 0.46$). Data are shown in Table 2.

The infection rate was compared with other variables in each group (Tables 3 and 4).

Discussion

In the current study, we compared the infection rate of hand laceration in patients receiving oral AB versus IV AB.

Our results showed that there was no significant difference between the routes of EB administration before the procedure ($P = 0.46$).

Based on the literature, the estimated rate of infection in hand laceration in the ED is 5-32% (10,12,15,16). Our study revealed a lower rate of infection in hand lacerations.

Berwald et al in 2014 evaluated the role of oral AB administration in the prevention of infection in simple hand laceration and they reported that infection occurred in 1% of patients (17). This rate is quite the same as our finding. This can be owing to the similarity of designs and methods used in both studies.

There are differences in the infection rate reported in different studies conducted in this field and many factors play a role such as the study design, AB selection, time of follow up and definition of wound infection (14).

There is no consensus about the predisposing factors involved in increasing the infection risk in hand lacerations. Today, the administration of ABs depends on the physician's point of view and patient's preference (17). Some studies suggested that diabetes mellitus, age, dimension of the wound, site of laceration and time of occurrence are the predisposing factors (18,19). Masmejean et al. in 2013 recommended ABs prescription in 1) wounds overlying an open fracture 2) bite wounds 3) situations with delay in suturing (20).

Stevens et al published a practical guide for treatment of infection in the outpatient setting. They suggested that in mild to moderate infections and in the absent of systemic signs, oral ABs are a reasonable choice. Failure of oral

Table 1. Comparing secondary outcomes between the two groups

Variable		Oral AB group	IV AB group	*P* value
Gender	Male	305 (79.8%)	319 (83.5%)	0.19
	Female	77 (20.2%)	63 (16.5%)	
Age		30.8 ± 12.7	31.6 ± 12.3	0.39
Time elapsed from the injury		1.9 ± 1.4	2.0 ± 1.3	0.28
Mechanism of injury	Sharp objects	133 (34.8%)	117 (30.6%)	0.22
	Accidents	249 (65.2%)	265 (69.4%)	
Depth of involvement	<1 cm	19 (5.0%)	11 (2.9%)	0.14
	>1 cm	363 (95.0%)	371 (97.1%)	
Side of involvement	One hand	377 (98.7%)	381 (99.7%)	0.22
	Two hands	5 (1.3%)	1 (0.3%)	
Site of involvement	One finger	191 (50%)	156 (40.8%)	0.07
	More fingers	31 (8.1%)	41 (10.7%)	
	Palm of hand	87 (22.8%)	96 (25.1%)	
	Back of hand	73 (19.1%)	89 (23.3%)	
Predisposing factors	Diabetes Mellitus	8 (2.0%)	8 (2.0%)	0.90
	Cardiovascular	13 (3.4%)	22 (5.7%)	
	Others	12 (3.1%)	4 (1.0%)	
	None	349 (91.5%)	348 (91.3%)	

Abbreviations: AB, Antibiotic; IV, Intravenous.

Table 2. Comparison of wound infection between the two groups

Variable	Oral AB group	IV AB group	*P* value
Fever	0 (0%)	1 (0.3%)	0.50
Erythema	9 (2.4%)	6 (1.6%)	0.43
Discharge	1 (0.3%)	1 (0.3%)	0.80
Edema	6 (1.6%)	7 (1.8%)	0.78

Abbreviations: AB, Antibiotic; IV, Intravenous.
*Chi-square test was used.

Table 3. Variables distribution in patients with wound infection in oral AB group

Variable		Oral AB group	*P* value
Gender	Male	9 (3.0 %)	0.69
	Female	1 (1.3%)	
Age (y)	<30	6 (2.4%)	0.75
	>30	4 (3.0%)	
Time elapsed from the injury (h)	<1	4 (2.3%)	0.51
	>1	6 (2.8%)	
Mechanism of injury	Sharp objects	133 (34.8%)	0.50
	Accidents	249 (65.2%)	
Depth of involvement	<1 cm	0 (0.0%)	0.60
	>1 cm	10 (2.8%)	
Side of involvement	One hand	9 (2.4%)	0.13
	Two hands	1 (20.0%)	
Site of involvement	One finger	4 (2.1%)	0.57
	More fingers	2 (6.5%)	
	Palm of hand	2 (2.3%)	
	Back of hand	2 (2.7%)	
Predisposing factors	Yes	1 (3.0%)	0.60
	No	9 (2.6%)	

Abbreviation: AB, Antibiotic.

Table 4. Variables distribution in patients with wound infection in IV AB group

Variable		IV AB group	*P* value
Gender	Male	6 (1.9%)	0.68
	Female	1 (1.6%)	
Age (y)	<30	4 (1.9%)	0.61
	>30	3 (1.7%)	
Time elapsed from the injury (h)	<1	4 (2.7%)	0.44
	>1	3 (1.3%)	
Mechanism of injury	Sharp objects	117 (30.6%)	0.44
	Accidents	265 (69.4%)	
Depth of involvement	<1 cm	0 (0.0%)	0.81
	>1 cm	7 (1.9%)	
Side of involvement	One hand	7 (1.8%)	0.98
	Two hands	0 (0.0%)	
Site of involvement	One finger	3 (1.9%)	0.51
	More fingers	1 (2.4%)	
	Palm of hand	1 (1.0%)	
	Back of hand	2 (2.2%)	
Predisposing factors	Yes	0 (0.0%)	0.52
	No	7 (2.0%)	

Abbreviations: AB, Antibiotic; IV, Intravenous.
*Chi-square test was used.

ABs, larger or deeper areas infected and in the presence of systemic signs, intravenous ABs should be prescribed (21). This guideline supports our results as the wounds we treated were mild to moderate.

The benefit of our study was that we excluded many of the confounding factors. We decreased type I and II errors thus the validity of the study increased. We also evaluated predisposing factors involved in wound infection in both groups; like age, gender, time of laceration, site of injury and underlying comorbidities and we did not find any significant differences between the two groups.

Several studies did not find a significant difference in the wound infection rate between patients who received oral and IV ABSs (12,22,23).

For example, Al-Nammari et al in 2007 studied the impact of prophylactic administration of AB in hand laceration. In this meta-analysis, it was determined that there was no significant difference in the infection rate between the group receiving prophylactic AB and the group which did not (24).

As our research demonstrated, there are only a few studies comparing the route or kind of AB administration in wound management.

Whittaker et al in 2005 designed a randomized trial on adult patients with trauma to the skin, tendon and nerve. Patients in group A received IV flucloxacillin followed by an oral placebo. Patients in group B received IV and then oral flucloxacillin. In a similar line, group C patients only received oral placebo. No statistically significant difference was found in the infection rates between the

three groups (8).

Zare et al in 2007 performed a similar study and they provided the same results as ours. In their trial patients were randomly divided into two groups. In the first group, they prescribed 1 g IV cefazolin before suturing and in the second group 500 mg cap cephalexin was given. Both groups continued treatment with oral cephalexin during the next 24 hours. Both groups had the same infection risk. Patients in both groups were highly satisfied with the treatment and its result (6).

These results are clinically important. Hand lacerations are among the most common complaints of patients referring to the ED. Unnecessary prescription of ABs will cause a great cost, side effects of drugs or antimicrobial resistance. Oral ABs are easy to administer and patients can correctly follow consuming instructions. Our results show that there might be no need to administer IV AB pre-procedure in hand laceration.

Limitations of the study

One limitation of our study is our sample size which might not be sufficient to detect the exact effects of drugs and adverse events. Further clinical trials with larger sample sizes and longer follow-up should be performed to identify adverse events. It was difficult to follow patients during 5 months, some were unwilling to answer our questions or refer for frequent visits.

Conclusion

On the basis of the results of this study, oral and intravenous ABs are not significantly different in terms of preventing wound infection and hence, administration of oral AB is preferable.

The study was approved by the ethics committee of Tehran University of Medical Sciences.

Authors' Contribution

MM, study design and supervision; NKT, data gathering and analysis; EV, drafting; ZN, data analysis; JS, study design; MS, critical revision.

Competing Interests

None.

Ethical Approval

The study was approved by the ethics committee of Tehran University of Medical Sciences (ethical code No: IR.TUMS.REC.1395.2845.) It was registered at Iranian Registry of Clinical Trials (identifier: IRCT201707118872N12; https://www.irct.ir/trial/9354). Moreover, informed written consent was obtained from all participants.

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