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Original Research Article

Evaluation of new scoring system predicting the occurrence of deep infection in open fractures patients

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ABSTRACT

Background: Open fractures of long bones incidence is 11.5 per 100,000 person per year. The management of open fractures had been improved by early adequate surgical debridement and various types of fracture fixation. The Gustilo classification is commonly used for treatment decisions and comparison. Although it had a good prediction power for deep infection but the variability among the inter observer was a problem. Yokoyama et al., 2009 he had advised a new scoring system based on three items of HFS-98 to predicting significant deep infections in open upper and lower extremity fractures.
Methods: This study was conducted at Emergency Department Suez Canal University Hospital on 233 Patients with open fractures of long bones from April 2014 till November 2015. The patients were classified according to the criteria proposed by Gustilo classification & Yokoyama's new scoring system. The relationship between the new score three items were investigated by categorical regression multivariate analysis.
Results: In this study, we had 233 Patients with open fractures of long bones. Road traffic accidents were the mechanism of injury in (44.6%). Deep infection was positive in 70/233 patients with Gustilo GI. The cut-off point of application of Yokoyama's new scoring system was 30, Sensitivity; 63.3%, Specificity; 89%, significant P-value <0.001.
Conclusions: The cut-off point of the new Yokoyama's new scoring application in this study was slit different from the reported applicable values before. This revised scoring system was thought to be useful for predicting deep. Further prospective trial is needed for advising new scoring system.

Keywords: Deep infection, New score system, HFS-98, Open fractures of long bones

INTRODUCTION

Usually open fracture is due to high energy trauma.[1] In open fracture the fracture hematoma is communicate to the exterior by skin laceration or skin loss that make all structures under the skin at risk to develop infection & other fracture complication.[2] The Outcome of management of open fracture had been improved by early prophylactic usage of antibiotics and early surgical debridement and early fixation either internally or externally.[3] The principles of open fractures management didn't change since world war one by doing a primary asepsis technique, then adequate debridement with early fixation & immobilization, and later protection of wounds against infection or reinfection.[4] The system of Gustilo and Anderson classification is commonly used for treatment decisions and comparison of published treatment results.[5] Although it had a good predictor power in predication of deep infection but the variability among the inter observer was also high.[6]

The Hannover fracture scale'98 (HFS-98) was created to emphasize upon the predictive indices of the limb salvage or the limb amputation.[7] It composed of eight items: bone loss, skin injury, muscle injury, wound contamination of infected organisms, deperiostation or not , local circulation & perfusion, systemic circulation & neurology using ATLS protocol for initial assessment.[8] It's considered that the HFS-98 could be useful for predicting the occurrence of deep infection in open tibial fractures, and as a utility for predicting the occurrence of deep infection in a newly developed scoring system based on the HFS-98 in previous studies.[5]

Based on Yokoyama et al, he had significance tests and univariate analyses on the eight items of HFS-98, with categorical regression analysis on the significant items to identify significant factors predicting deep infections in open upper and lower extremity fractures.[5] Resulting in the new scoring system items which are: muscle injury: 0– 20 points, wound contamination: 0–20 points, local circulation: 0–20 points, and clarified that the cut-off point for occurrence of deep infection in open extremity fractures was 35 by ROC analysis.[5]

In this study we tried to evaluate (Yokoyama new scoring system) devised by Yokoyama et al in 2009 as new scoring system of open upper and lower extremity fractures based on the basis of the Hannover Fracture Scale'98 (HFS-98).[5] Aiming to evaluate the new scoring system in predicting the occurrence of deep infection on open fracture patients.

METHODS

This is a prospective study was conducted at Emergency Department Suez Canal University Hospital on 233 Patients with open fractures of long bones from April 2014 till November 2015. Inclusion criteria were all adult patients (males and females) aged over 18 years presenting with long bones open fracture, were eligible. Exclusion criteria were patients undergoing immediate or delayed amputations due to deficient limb circulation, patients with brain death or death due to severe vital organ injuries or patients known to be immunocompromised, diabetic, sepsis, corticosteroids usage, auto immune disease & malignancy.

Demographic and clinical data were collected via specific data sheets filled by the researcher and from the medical records of patients in the Department of Emergency medicine at Suez Canal university hospital.

The patients with open long bones fractures was classified according to the criteria proposed by Gustilo classification.[9] The relationship between the three items of Yokoyama's new scoring system as given in Table 1 based on Hannover Fracture Scale'98 (HFS-98) and Gustilo's grade in the open extremity fractures were investigated by categorical regression multivariate analysis.[5,6]

broad spectrum antibiotics or in combination with an aminoglycoside was given for all types of fractures. prophylaxis against tetanus was administered to all patients. after patient's initial assessment according to abcde approach of Advanced Trauma Life Support (ATLS), the open wound was irrigated and debrided. Coverage methods for soft tissue for Gustilo (type I) was primary skin closure. Coverage soft-tissue methods for Gustilo (type II) could be delayed primary sutures or secondary skin grafting, or local flaps. The coverage methods for Gustilo (type III) could be delayed local muscle flaps or fasciocutaneous flaps and or free tissue transfers. The Coverage's was performed within 1 week.

Table 1: Yokoyama new scoring system.

Category	Score
Muscle injury	
No	**0**
<1/4 circumference	**5**
1/4-1/2circumference	**10**
½-3/4 circumference	**15**
>3/4 circumference	**20**
Wound contamination	
No	**0**
Partly	**10**
Massive	**20**
Local Circulation	
Normal pulse	**0**
Capillary pulse	**5**
Ischemia≤4 hours	**10**
Ischemia 4-8 hours	**15**
Ischemia>8 hours	**20**

Diagnosis of deep infection was defined as clear counts of some bacterial organisms from bone or tissue below the muscular fascia according to Dellinger et al.[10]

Statistical analysis

The data were entered, cleaned and analyzed using SPSS software version 18.0. Descriptive statistics like frequency distribution and percentage calculation was made for most of the variables. Chi-Square and ROC cures were used to examine the relationship regression multivariate analysis between variables. A P <0.05 was considered statistically significant.

RESULTS

In this study, we had 233 Patients with open fractures of long bones, the age of the studied patients ranged from (18-78) years old with mean age 36.09±14.3. This study showed that the majority of the studied patients were males (88.4%).

Regarding the mechanism of trauma, this study showed that road traffic accidents was the mechanism of injury in

(44.60%) of the studied patients. Isolated fracture was 36.5%, while 12% of the patients had combined injuries due to multiple trauma. This study showed that 55.3% of the culture and sensitivity of the studied patients at arrival showed no growth, while 48% of the culture and sensitivity of the studied patients inward showed no growth with different organisms as shown in Figure 1.

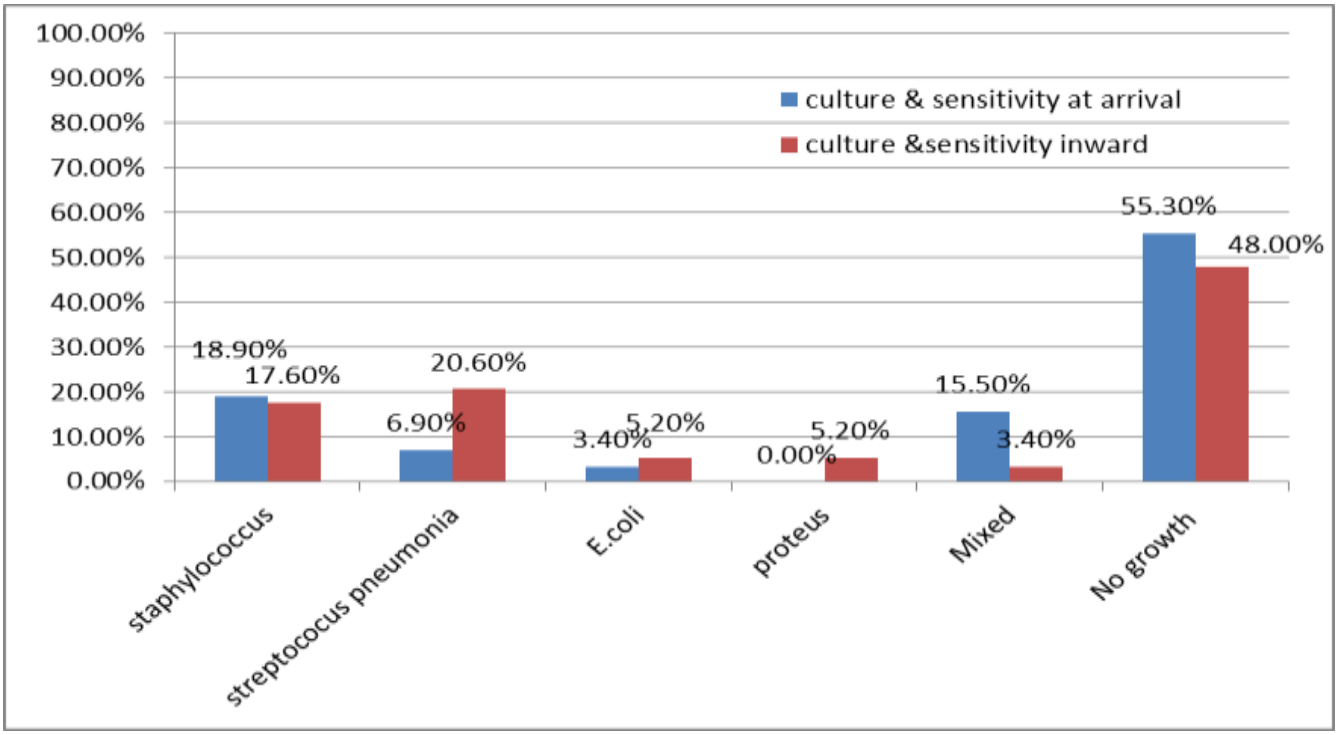


Figure 1: Distribution of studied patients according to culture and sensitivity at arrival and inward.

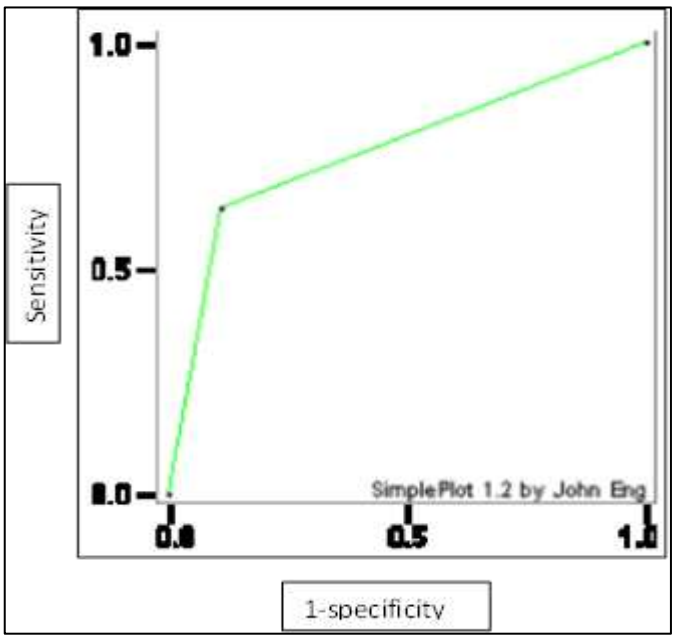
Deep infection was positive in 10.3% of the studied patients with ISS score <18 and 16.1% with score (18-30) and 66.7% with score >30.

Infection in deep tissues was positive in 70/233 patients with Gustilo classification, (G) I: 13.1% (18/137), G II: 33.3% (8/24), G IIIA: 50% (20/40), G IIIB: 60% (12/20), and G IIIC: 100% (12/12) as given in Table 2.

Deep infection was seen in 70 patients (G I: 13.1% (18/137), G II: 33.3% (8/24), G IIIa: 50% (20/40), G IIIb: 60% (12/20), GIIIc: 100% (12/12) with significant relation to grade of Gustilo classification when processed in multivariate as given in Table 2.

The cut-off point of the Yokoyama's new scoring system was 30, Sensitivity; 63.3%, Specificity; 89%, PPV; 45%, NPV; 93.8, significant P-value <0.001*. And the area under curve will be 74% as presented in Figure 2.

The cut-off point of the Gustilo was GII, when area under curve was be 77%, sensitivity will be 74.3%, specificity 97.2%, with P significant value positive =0.001. The ISS score cut-off point of was 18 when area under curve was be 78%, sensitivity will be 90%, specificity 62.6%, with P significant value positive =0.001.



Turnover point score; 30, Sensitivity; 63.3%, Specificity; 89%, PPV; 45%, NPV; 93.8, P-value <0.001*significant.

Figure 2: Illustration of the ROC analysis applied on the present study group employing the Yokoyama's new scoring system.

Table 2: Distribution & relation between Yokoyama new scoring system items parameter & infection compared to Gustilo and Anderson classification items & infection.

Item			Deep infection	*P* Value in		
				Univariate	Regression	Multivariate
Muscle Injury	Absent		16.1% (22/137)	0.1	0.1	0.001*
	Present	<1\4 circumference	0			
		1\4-<1\2 circumference	33.3% (12/36)			
		1\2-3\4 circumference	54.5% (24/44)			
		>3\4 circumference	75% (12/16)			
Wound Contamination	Absent		14.5% (17/117)	0.01	0.15	<0.001*
	Present	Partly	25% (17/68)			
		Massive	75% (36/48)			
Deperiostation	Absent		25.4% (46/181)	0.7	-	-
	Present		46.2% (24/52)			
Local Circulation	Normal pulse		18.4% (34/185)	0.01*	-0.3	<0.001*
	Capillary pulse only		71.4% (20/28)			
	Ischemia <4 hours		75% (12/16)			
	Ischemia 4-8 hours		100% (4/4)			
	Ischemia >8 hours		0			
Systemic Circulation	Constantly >100		13.9% (14/101)	0.02*	-	-
	Until admission <100		17.2% (11/64)			
	Until operation<100		54.5% (24/44)			
	Constantly <100		87.5% (21/24)			
ISS	<18		10.3% (7/68)	0.01*	-	-
	18-30		16.1% (15/93)			
	>30		66.7% (48/72)			
Gustilo	G1		13.1% (18/137)	0.2	-	<0.001*
	G2		33.3% (8/24)			
	G3a		50% (20/40)			
	G3b		60% (12/20)			
	G3c		100% (12/12)			

DISCUSSION

In this study, the age of the studied patients ranged from (18-78) years old with mean age 36.09±14.3. These results going with the results of another studies in which the age of the studied patients varied from (20-56) years with the mean age was 38 years.[5,6,11]

Road traffic accidents was the higher rate of mechanism of trauma, isolated fracture was the dominant followed by the combined injuries and those results agrees with the results of other study in which the mechanism of injury was motorcycle accident in (57%) of the patients followed by motor car accidents in (20%), and 11% of the patients had combination of injuries with other fractures.[12,13]

Regarding ISS score, this study showed that 29.2% of the studied patients had score <18 while 39.9% of them had score (18-30) and 30.9% of them had score >30. These results don't agree with the results of a study conducted by Yokoyama K et al, in which 69.3% had ISS score <18, (22.1%) of them had score (18-30) and (8%) of them had score >30 this variation could be due to the nature of accident direct or high velocity traumas.[5,12,13]

Regarding Gustilo classification, this study showed that 58.8% of the patients had GI. Unlike the results of the study performed by Yokoyama K et al, in his two researches which 15%, 17% of patients had GI respectively.[5,6] Also these results not going with the results of a study conducted by Agel et al, in which 14.6% of the patients had GI.[14]

This culture and sensitivity studies of 55.3% of the patients showed that no growth at arrival, while 48% of the culture and sensitivity of the studied patients inward showed no growth as shown in Figure 1 with different organisms that we can't rely on the culture in diagnosis of deep infection separately without suggested clinical picture. These results agree with the results of a study performed by Hannigan GD et al. The collected swabs from patients with open fractures upon presentation to

ED only 24% of surveillance cultures showed growth. 77% of the infected wounds showed negative cultures.[15]

This study showed that deep infection were seen in 70 patients (G I: 13.1% (18/137), G II: 33.3% (8/24), G IIIA: 50% (20/40), G IIIB: 60% (12/20), GIIIC: 100% (12/12) with significant relation to grade of Gustilo classification when processed in multivariate.

These results don't match the results of a study performed by Yokoyama K et al**,** deep infections were seen in only 32 patients G I: 0% (0/65) , G II: 2.2% (3/133), G IIIa: 5.9% (4/68), G IIIb: 27.1% (19/70), and G IIIc: 37.5% (6/16).[15] The increased rate of infection in the study group could be due to bad manipulation & delayed transfer and suturing of the fracture wound , G II: 2.2% (3/133), G IIIa: 5.9% (4/68), G IIIb: 27.1% (19/70), and G IIIc: 37.5% (6/16).

The cut-off point of the Yokoyama's new scoring system in our study was 30, showing sensitivity; 63.3%, specificity; 89%, PPV; 45%, NPV; 93.8, significant P-value <0.001*. Those results were slit different from Yokoyama K et al, results demonstrating a cut point of 35 and the sensitivity, specificity, positive predictive value, and negative predictive value in this cut-off point were 0.67, 0.92, 0.66, and 0.98, respectively.[5]

CONCLUSION

The cut – off point of the new Yokoyama's new scoring system application in this study was slit different from the reported applicable values before. This revised scoring system was thought to be useful for predicting deep infection in open upper and lower extremity fractures. Further prospective trial is needed for advising new scoring system. The system of Gustilo and Anderson Gustilo classification still the gold stone score for treatment decisions, comparison of published treatment results although it's problematic inter-observer agreement.

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Conflict of interest: None declared
Ethical approval: The study was approved by the Research Ethics Committee of Faculty of Medicine Suez Canal University

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