

Exposed Bone Syndrome: Classification and Scoring of Exposed Long Bone

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Citation

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Abstract

Introduction:

There is paucity of literature on exposed bone (EB) classification. We aimed at classification and scoring of exposed long bones of limb.

Patients and Methods:

A clinical based observational prospective non-randomized three years study of EB was evaluated at tertiary teaching hospitals. Patient's informed consent and institutions ethical clearance were obtained. Research question was EB's are not the same. The type I (AEB) and type II (CEB) were EB occurring for less than six weeks or more respectively. The type I and II EB patients constituted what we coined "Exposed Bone Syndrome" (EBS). One major symptom and one major sign with two or more symptoms and two or more minor signs constituted diagnostic EBS criteria. The measuring instrument was Ile- lfe EBS protocol. Outcome measures were duration of hospital stay and mortality. Data was analyzed with SPSS version 11.0 software using Pearson correlation, Yates's coefficient, Spearman correlation, Mantel-Haenszel odd ratio package. The alpha error level was $p < 0.05$.

Results: A total of 155 EB patients (111 males=71.6%; 44 females= 28.4%) with 74.2% in lower limb and 25.8% in upper limb met the inclusion criteria's. Trauma was the main predisposing factor to EB ($p < 0.000$). The age, sex, religion, location of EB, body side involvement, blood use, genotype, fever and blood chemistry were not significant. The presence and number of EB, bone viability ,length of bone exposed, haemogram, microorganism, pain, bleeding, recurrent discharge ,deformity ,sinuses, joint exposure, putrefying odor , hyper pigmentation, hypo pigmentation ,exuberant hair growth ,puckered scar, rocking detachment and limb length discrepancy were significant symptoms and signs ($p < 0.05$) in EB classification. A preliminary scoring of the significant clinical features of EB that ranged from 9-44 was documented.

Conclusion: Exposure of bones is often seen in clinical orthopedics practice. Management of exposed bone portends a great challenge to the surgeons. Exposed bone syndrome is a distinct clinical entity that could be classified into two types using Ile lfe diagnostic protocol. McInre Exposed Bone Scoring System (MEBSS) is simple to apply and reproducible for epidemiology and management of exposed bone.

INTRODUCTION

Bone retains the capacity to alter its shape and structure in response to changes in its environment ¹. Accidents related to road traffic, industrial machinery or farming can result in mangle injuries with bone exposure. The goals of skeletal fixation in this setting should include: stabilization of the skeleton in order to protect the vascular repair, facilitation of early mobilization of both the articulations and the gliding musculotendinous structures of the limb, facilitation of wound care and reconstruction of soft tissue envelope and

healing of all fractures including those associated with bony defects².

Adequate debridement remains the most important factor in prevention of chronic sepsis in cases of massive limb trauma. All bony fragments with marginal soft-tissue attachments and exposed bone without evidence of adequate blood flow must be removed during debridement for optimal results ³. When the fracture site is infected and contains necrotic fragments, the superiority of external fixation over internal fixation is obvious. The method makes it possible to

stabilize the fragments without interfering with local healing and allows the exposed bone to be covered in a stable environment⁴.

Exposure of bones is often seen in clinical orthopedics practice in the developing countries. Management of EB portends a great challenge to the surgeons and this often varies with the etiology and mode of presentation. There is paucity of literature on exposed bone in sub-Saharan Africa. The problem of exposed bone has been of long standing but no clear pattern has been described. This study is aimed at evaluation of a new classification and scoring system for exposed bone as seen at tertiary teaching hospitals in Nigeria.

PATIENTS AND METHODS

A descriptive observational non randomized study of exposed bone (EB) patients at University Teaching Hospitals setting was evaluated prospectively from 1st January 2004 and 31st December, 2006.

The protocol for the study was established prospectively. The guidelines were as follows: patients with history of open fractures without exposed bone at presentation in the hospital were excluded, all EB were to be treated as surgical emergency, wound swabs were to be taken for culture and sensitivity tests before commencement of antibiotics, tissue biopsy and underlying etiological factors were investigated. The plain radiographs of affected limb was documented, individualized limb splintage, anti-tetanus prophylaxis as well as antibiotics combination Cefuroxime (Zinacef) and Gentamicin were given in divided doses for 72 hours in order to cover a broad spectrum of microorganisms. Open fractures were classified using Gustilo-Anderson classification. Acutely exposed bones had thorough wound debridement and copious fluid irrigation, dirty and contaminated wounds were to be closed by delayed primary wound closure after they had become sufficiently "clean", exposed bones were "rocked out" under aseptic condition, the cavity packed with sterile surgical gauzes. The methods for stabilizing the fractured EB includes Plaster of Paris, external fixation and definitive care such as non vascularized skin grafting, autogenous bone grafting, and amputation among others. The patients were divided into two groups based on the mode and time of presentation. Choice of six weeks as boundary was mainly guided by clinical observation that a persistently exposed bone for a period longer than six weeks portend poorer prognosis irrespective of the etiology. The type I and II EB patients constituted

what we coined Exposed Bone Syndrome (EBS). EBS could be recognized clinically with symptoms and signs outlined in table 1 and 2.

Figure 1

Table 1: Ile -Ife Protocol For Exposed Bone Syndrome Diagnosis

Symptoms	Signs
Major-	Exposed bone
Protruded bone	(Free-Complete / Incomplete)
Minor-	Minor-
Bleeding	Tenderness
	Hemorrhage
Pain	Putrefying odor.
Discharge	Hyper pigmentation
	Hypo pigmented skin
Deformity	Exuberant hair growth
Joint exposure	Puckered skin
	Limb Length Discrepancy
	Open Joint articulation

Figure 2

Table 2: Summary of EBS diagnostic criteria

EXPOSED BONE SYNDROME
One major symptom and one major sign.
Two or more minor symptoms and
Two or more minor signs.
< 6 weeks (Type I=AEB)
>6 weeks (Type II=CEB)

The EB was scored with value ranged from 0-3 point for a categorized clinical feature. Exposed bone is assigned with point value of 3 because of orthopedic emergency it connotes in clinical practice. The features of symptoms and signs were assigned the value of 1 and 2 points respectively reflecting the level of severity.

The measuring instrument was Ile- Ife EBS protocol. Outcome measures were duration of hospital stay and mortality. Data was analyzed with SPSS version 11.0 software using Pearson correlation, Yates's coefficient, Spearman correlation, Mantel-Haenszel odd ratio package. The alpha error level was $p < 0.05$.

RESULTS

A total of 155 EB patients (111 males=71.6%; 44 females=28.4%) with 74.2% in lower limb and 25.8% in upper limb met the inclusion criteria's. The age($X^2=5.426, p>0.066$), sex($X^2=3.175, p>0.075$), religion($p>0.453$), location of EB in lower or upper limb ($X^2=3.632, p>0.163$), body side involvement ($p>0.406$), genotype($X^2=3.374, p>0.185$), transfused/not transfused as related to blood use($X^2=0.842, p>0.359$), limb contracture($p>0.879$, OR 0.151,), fever($p>0.640$, OR -5.888), electrolyte and urea ($X^2=2.376, p>0.123$) were not significant in the classification of exposed bone. The various features of EBS are shown in figures 1 to 5 .

Figure 3

Figure 1: Exposed Humerus of type I EBS .



Figure 4

Figure 2: Exposed Tibia of type I EBS.



Figure 5

Figure 3: Exposed Fibula of type II EBS .



Figure 6

Figure 4: Exposed Radius of type II EBS



Figure 7

Figure 5: Exposed Tibia of type II EBS from Squamous cell carcinoma.



The mode of presentation ($p<0.000$, OR 5.841), pain ($p<0.000$, OR 4.901), bleeding ($p<0.000$, OR 3.90), duration of bone exposure ($X^2=33.428$, $p<0.000$), length of bone exposed ($X^2=11.44$, $p<0.022$), number of bone exposed ($X^2=12.960$, $p<0.002$), bone viability at presentation ($p<0.000$, OR 5.410) differ between AEB and CEB patients. The other significant symptoms and signs include, associated trauma/non trauma ($p<0.000$, OR 4.203), tenderness ($p<0.000$, OR 4.901), recurrent discharge ($p<0.000$, OR 5.871), deformity ($p<0.035$, OR 2.126), sinuses ($p<0.000$, OR 4.343), joint exposure ($p<0.000$, OR 4.006), free exposed bone ($p<0.000$, OR 6.463), hemorrhage ($p<0.000$, OR 4.352), putrefying odor ($p<0.013$, OR 2.522), hyper pigmentation ($p<0.000$, OR 3.606), hypo pigmentation ($p<0.000$, OR 3.681), exuberant hair growth ($p<0.000$, OR 7.918), puckered scar ($p<0.000$, OR 8.100), limb length discrepancy ($p<0.012$, OR 2.538), associated fracture/epiphysis slippage ($X^2=65.890$, $p<0.000$), wound edge eversion ($p<0.000$, OR 4.159) and rocking detachment ($p<0.000$, OR 6.457). The laboratory findings and therapy pattern also differ in EB when type I was related to the type II. As seen in the haemogram ($X^2=35.887$, $p<0.003$), white

blood cell count ($p<0.000$, OR 24.8), erythrocyte sedimentation rate ($X^2=70.813$, $p<0.000$, OR 10.7), microorganism ($X^2=31.867$, $p<0.000$, OR 4.1), biopsy ($P<0.000$, OR 6.2) revealed significant variation in the evaluated EB patients. Instituted therapy such as polytherapy / monotherapy for EB ($X^2=27.894$, $p<0.000$, OR 2.6), hospital stay ($p<0.002$, OR 1.353), duration of wound to heal ($p<0.000$) were significant in the classification of EB. A preliminary scoring of the exposed long bone was based on the significant clinical features. The EB symptoms and signs were scored ranging from 9-44 detailed in table 3.

Figure 8

Table 3: McLanre Exposed Bone Scoring System.

Symptoms	EB features	Score point value	Laboratory	EB features	score point value	Signs	EB features	Score point value
Mode of presentation	Non emergency	1	Haemogram (gm/dl)	>8.0	1	Exposed bone	Absent	0
	Emergency	2		<8.0	2		Present	3
Duration of EB	>6weeks	1	White Blood Cell	Normal	0	Tenderness	Absent	0
	<6weeks	2		Leucocytosis	1		Present	1
Length of EB	<5cm	1	Erythrocyte Sedimentation Rate	Normal	0	Deformity	Absent	0
	>5cm	2		Elevated	1		Present	1
Number of EB	One	1	Microbiology	Bacteria	1	Sinus	Absent	0
	>One	2		Non bacteria	2		Present	1
Bone viability	Viable	1	Imaging	No fracture	0	Mobility	Not free	1
	Not viable	2		Fracture	1		Free	2
Pain	Absent	0	Biopsy	Fracture/Epiphysis	2	Joint	Not exposed	0
	Present	1		Normal	0		Exposed	2
Bleeding	No bleeding	0		Non specific	1	Putrefying odor	Absent	0
	Active bleeding	1		Specific	2		Present	1
Discharge	Absent	0				Exuberant hair growth	Absent	0
	Present	1					Present	1
Etiology	Non trauma	1				Puckered scar	Absent	0
	Trauma	2					Present	1
Protruded bone	Absent	0				Limb length discrepancy	Absent	0
	Present	3					Present	1
						Hypo pigmentation	Absent	0
							Present	1
						Hyper pigmentation	Absent	0
							Present	1

DISCUSSION

Exposed long bone occurred in all age group without significant difference in the type seen based on age .The predisposing factors to a type of bone exposure are similar within the same patients' age group . The male sex is more predominant in having long bone exposure however there is no difference from female sex when relating gender to EB type. . The length of exposed bone varies with the duration of exposure both features are useful in the EB classification. The acutely exposed bone is usually longer, attached to periosteum or soft tissue and of shorter period of exposure. Avulsion, degloving and severe laceration injuries are related to type I EB. AEB that is presenting less than six hours of exposure often still retain normal architecture. Chronic exposed bone type II is averagely usually shorter in length due to progressive crumbling of their exposed necrotic terminal end during dressing compared with

resilient AEB. The Type II exposed bone is devoid of vascularized periosteal coverage for more than six weeks⁵. The number of exposed bone seen in the type I are more often multiple as compared to the type II that is single. Road traffic injury, infection and metabolic diseases are associated with multiple bone exposure.

Many things has been written on open fracture^{6,7,8,9,10} but no literature is available on the Classification of Exposed long bone. And rarely the joint bones could be exposed¹¹. It is not all open fracture and osteomyelitis that do result in exposure of bone. The EBS features are distinct with very good reproducibility among patients. The location and side of the body where EB was found either upper or lower limb, left /right was not significant in the classification. The underlying factors affect the limbs possibly in equal proportion. Trauma and metabolic diseases are associated with type I EB while infection and neoplasm are seen in type II EB. Type I EB presents as emergency as compared to type II EB which is seen more common in non emergency units. The haemogram is significantly lower in type I EB due to active hemorrhage however it tend to be generally within normal range in the type II EB patients. The possibility of blood use is more common in type I EB when related to type II EB patients. The exposed marrow cavity oozed blood out in long bone when exposed acutely which is connected with large volume of fluid and blood transfusion. The mean blood chemistry is not statistically significant between the AEB and CEB patients. The erythrocyte sedimentation rate and white blood cell count is usually raised in type II EB as when compared to type I EB related to associated factors. Imaging revealed more of fractured bone/epiphysis slippage in type I EB and pathological fracture/Sequestrum in type II EB. The microbiology pattern differs from AEB and CEB. Non bacterial fungal culture and mixed growth is related to EB beyond 6weeks and bacterial culture associated with AEB. Biopsy of exposed bone in type II could be diagnostic of neoplasm, deep mycosis and avascular necrosis as compared to non specific infection of type I EB.

In exposed long bone pain and tenderness is predominant in type I EB patients'. It is related to acute exposure of the nerve receptor endings in living bones and soft tissue which is absent in CEB. Acute limb deformity, limb length discrepancy, hemorrhage and joint exposure are seen more in type II EB patients. The length of bone is usually longer in AEB thereby significant enough to cause limb shortening, deformity and joint disruption. The deformity seen in CEB is usually chronic in onset and related to complication of

treatment or neglect. CEB patients do present with characteristic surrounding exposed bone skin hyper pigmentation, hypo pigmentation, exuberant hair growth, puckered scar and free/incomplete free exposed bone. Reflex sympathetic dystrophy¹² appeared to be significant in the skin changes seen in type II EB but absent in AEB patients. Pain, edema and autonomic changes are usually present at the onset, with motor and trophic changes becoming evident later. Partially loose or completely free exposed bone make rocking detachment easy more in CEB patients unlike AEB.

Variables that have been analyzed for possible association with outcome of exposed bone range from patient demographic data to specific characteristics regarding the exposed bone. When changes associated with age and gender is needed to be considered in the scoring of EB, the type of EB and etiology becomes more significant. The McInre Exposed Bone Scoring System (MEBSS) is valuable for the epidemiologic needs, gathering of data and monitoring of exposed bone irrespective of the etiology. It is applicable in the realm of non trauma related exposed bone. It is simple to apply and provide quantification tools in assessing the severity of exposed long bone.

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