Evaluation and Management of Wartime Civilian Gunshot Wounds of Extremities in a War Torn African Country

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Summary:

Background: Military orthopedic surgeons frequently treat combat gunshot wounds. Civilian Gun Shot Wound (GSW) of the limb is not uncommon in wartime but it differs from peace time casualty in terms of contamination and wounding potential of firearms. There is always a decision making dilemma to divide wounds for conservative irrigation and aggressive debridement.

Objective: To set criteria to divide wound for conservative irrigation and aggressive debridement and to review our experience with this treatment regime.

Method: This was a prospective observational study from February to July 2011 in a United Nations Level-II hospital. All civilian GSW were classified into two groups according to laid down criteria. All low velocity minor GSW were grouped as minor wound and was treated conservatively with wound irrigation and marginal excision whereas all high velocity severe wounds were treated with aggressive wound excision. A short course of antibiotic was given to all patients. Patients' demography, photograph and forensic evidence were recorded as much as possible.

Results: In total, 56 patients sustained GSW. Forty four (79%) received only soft tissue injury and 12 (21%) received bony injury in addition. Highest 75% received injury to lower limbs. Fifty five (55%) percent were treated with conservative irrigation with marginal excision and 45% were treated with aggressive wound debridement. 25% fractures were treated with primary open reduction and internal fixation (ORIF), remaining 75% were treated with Splintage. Overall complication rate was 30%. Common complication was wound infection (20%). Infection rate was 4% in irrigation group and 16% in aggressive debridement group.

Conclusion: Inspite of wartime austerity and constraints civilian GSW can be managed effectively with wound irrigation and debridement.

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Introduction:

By the curse of war against terrorism and terrorist attacks peacetime civilian Gun Shot Wounds (GSW) are common all over the world and to some countries it is almost epidemic[1]. Indirect participation in war, crossfire, wrong targeting and accidental wound following mishandling of firearms all may lead to civilian casualties. A team headed by an orthopedic surgeon is required to treat battlefield casualties[2]. It requires a special challenge because here professional efficiency must be blended with the physical and mental strength, emotional stability, devotion and ability to work in adverse situation with resource constrains. Peacetime GSW of civilian is quite different from wartime because of wounding potential of firearms and degree of contamination[3]. In our situation, where military weaponry was used on civilians, the nature of wound was not much different. As a member of United Nations Operation in Cote d'Ivoire (UNOCI), at Daloa, a remote district, where hospital facilities and trained civilian doctors were inadequate and people were financially poor, civilian war casualties rushed to UN military hospital as their last resort to save life. Because of the high incidence of this type of injury civilian hospitals should have wartime preparedness to meet demand. The treating surgeon must have a good knowledge in

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anatomy because Gunshot injury may produce a complex injury involving muscle, vessels, nerves, bones, and tendons[4]. There is always a decision making dilemma to divide wounds into two groups for conservative and aggressive surgical debridement respectively. The aim of this study was to set criteria for each group of wounds and to review our experience of dividing and treating these wartime civilian GSW of the extremities.

Methods:

This prospective study was carried out in a United Nations (UN) level-II hospital over a period of six months from February to July 2011. We treated 56 patients with 62 gunshot wounds to different parts of the extremity. Civilians of any age and sex having multiple or single GSW to extremities were included in this study. It is neither the bullet velocity nor the amount of energy transfer but the extent of soft tissue damage and the nature of fracture that dictates the treatment choice[5]. "It is the wound, not the bullet"[1]- was the decision making principle. After proper resuscitation and stabilization with standard Advanced Trauma Life Support (ATLS) method[7]all patients underwent radiological examination. All wounds were cleaned with surgical scrub brush and solution. Minor (Low velocity), fresh (<24 hours), apparently clean wound of <2cm in diameter (entry/ exit), without major vessel or nerve injury and without fracture[5] or joint involvement were treated with irrigation and minimal wound (marginal) excision under Local anesthesia. Whereas high velocity wound; contaminated, infected wound or discharging (serous or serosanguinous discharge with pressure) wound; wound with fracture, injured vessel or nerves; wounds of >24 hours duration[6] , wounds involving joint- all were treated with aggressive debridement in operation theatre under either regional or general anesthesia.

All wounds were left open and redressed daily to check for infections. Noninfected wounds were closed delayed primarily (within 4-6 days) whereas infected wounds underwent daily aseptic dressing until they were fit for secondary closure (SC) or fasciocutaneous flap (FCF) or Split Thickness Skin Grafting (STSG). All patients were given a 3-days course of antibiotics (oral ciprofloxacin 500mg12 hourly for minor wounds, and IV ceftriaxon1 gm daily for severe wounds). Infected wounds received an additional 05 days course of oral ciprofloxacin. After wound closure all wounds were followed up every third day till wounds have healed. Thereafter they were followed up weekly for the first month and follow up continued fortnightly for the fractures till they unite.

Result:

Out of 56 patients 34(61%) were male and 22(39%) were female. Age range was 7-62 years, (mean 25.4, median 24). Table-I shows the age and sex distribution. Time interval between injury and hospital reporting was 30 minutes to 7 days (Table-II). Maximum number (39%) of patients reported after24 hours with highest incidence (10%) of post operative infections. Forty four (79%) patients had soft tissue injury and 12(21%) had bony injury as well. Total 42(75%) patients had injury to lower limbs, 07(13%) in the upper limbs, 04(7%) gluteal region, 03(5%) in the back (Fig-I). Four (7%) patients had multiple injuries. Among twelve (21%) patients, 10(17%) had lower limb and 02(4%) had upper limb fractures (Fig-II). Thirty one (55%) patients were treated with conservative irrigation with marginal excision and twenty five (45%) were treated with aggressive wound debridement. Only 03(5%) patients underwent ORIF, rests 9(16%) patients were treated conservatively. One (1.7%) patient had vascular injury. Four (7%) patient developed nerve injury. Overall complication rate was 30% with wound infection highest. Total 11(20%) patients developed wound infection; among them 2(4%) in irrigation group and 9(16%) in aggressive wound debridement group. Total 50 (90%) patients were irregular either in medicine intake or dressing change and everybody were very casual about personal hygiene. Hospital stay for only soft tissue injury was 06 hours to 48 hours and for patients with associated injury it was 08 (Range 7-14) days. Ultimately all wounds have healed and fracture united (Table-III).

Table-I

Distribution of age and sex of treated patients (n=56)

Age		Sex	
In years	No (%)	Male	Female
7-20	15(27)	10(18)	5(9)
21-40	33(59)	20(36)	13(23)
41-60	04(7)	1(2)	3(5)
>60 years	04(7)	3(5)	1(2%)
Total	56(100)	34(61)	22(39)

Table-II

Distribution of wound according to treatment modalities and infection (n=56)

Time between injury & wound care(Hours)	Number (%)	Treatment modalities			
		Wound Irrigation		Wound Debridement	
		Number	Infection	Number	Infection
<_6	18(32)	17	1	1	1
6-12	06(11)	06	-	0	1
12-18	04 (7)	3	1	1	1
18-24	06(11)	5	-	1	-
>24	22(39)	0	-	22	6
Total	56(100)	31(55%)	2(4%)	25(45%)	9(16%)

Table-III

Treatment Modalities and wound healing (n=56).

Treatment modalities	No. of	Wound healing			Fracture management by		
	Patient (%)	DPC*	SC*	FCF*	STSG*	ORIF	Splintage
Wound irrigation only	31(55)	15	9	0	07	0	04
Aggressive debridement	25(45)	07	11	02	05	03	05
Total	56(100%)	22	20	02	12	3	9

*DPC-Delayed Primary Closure, SC-Secondary closure, FCF-Fascio-Cutaneous Flap, STSG-Split Thickness Skin Graft.

Table-IV

Outcome of treatment by study

Legend	Ordog et al.(%)	Alon Burg et al. al.(%)	Present study (%)
Fracture		60	21
Primary ORIF		8	5
Nerve injury		16.8	7
Outpatient treatment	60		79
Complication rate		30	30
Infection with wound irrigation	1.8	-	2

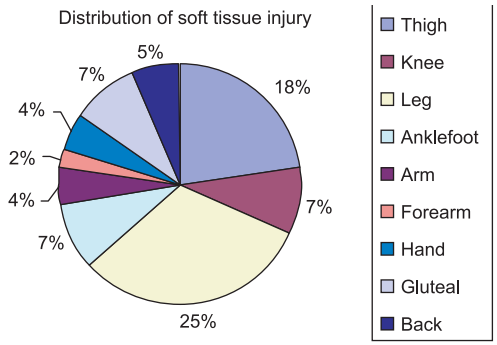

Fig.-1: *Distribution (%) of soft tissue injury (n=44)*

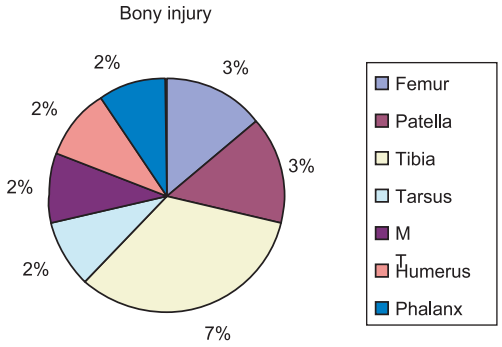

Fig.-2: *Distribution (%) of bony injury (n=12)*

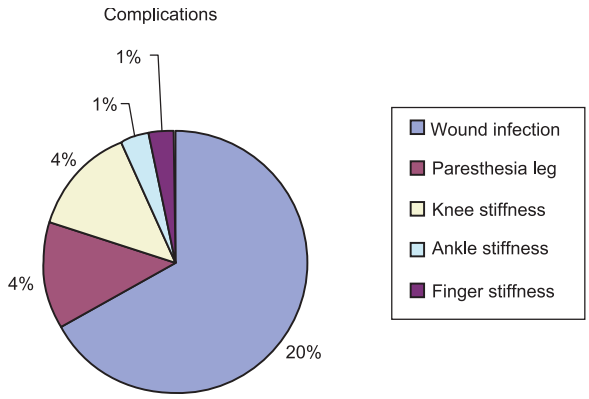

Fig.-3: *Complications (n=56).*

Discussion:

Wartime wounds are caused by Missiles that include pistol or rifle bullets, shell fragments, land mines and granades[9]. Most modern guns are fired at low velocity (<2000feet/sec) [10] and have low available energy (50-100 J) and result in low energy transfer wounds. Missiles that are fired at high velocity (2000ft/sec) e.g. assault rifle, with high available energy (2000-3000 J) produce high energy transfer wound[11]. A missile damages the tissue by transferring all or part of its available energy. The amount of energy transferred is expressed by formula KE=1/2 M ($V1^2$-$V2^2$) where KE= available energy, M=mass, V1 and V2 are the velocities at entry and exit[11]. A bullet has got three effects on tissues: sonic pressure wave, permanent cavitations and temporary cavitations. The sonic pressure wave is of short duration, precedes bullet and can produce upto117 atmos of pressure and usually causes no significant tissue damage[12]. The permanent cavity is caused by direct tissue crushing and laceration along the missile track[3,12]. The phenomenon of temporary cavitations is manifested only in high energy transfer wound. It can reach upto10-40 times the diameter of the bullet[3]. The temporary cavity creates negative pressure which sucks contaminants from outside and poses a special threat of infection[12].

Primary Health care is a basic right but surprisingly half of the world population is deprived of it and more astonishingly two third of them lacks orthopedic care[13]. In our situation, due to long standing political unrest, damaged or underdeveloped infrastructure, inadequate trained manpower, poor pecuniary circumstances, low education level, bad personal hygiene, poor nutritional status all has compounded the problem manifold. The success of war wound surgery depends on strict adherence to four basic principle i.e. meticulous wound cleaning/debridement, immobilization, delayed wound coverage and antibiotics. There should be meticulous recording of all findings and proper photograph and forensic evidence should be preserved in all civilian cases[1,14]. In one series of GSW management Ordog et al[15] reported 60% treatment as outpatients with 1.8% infection rate and overall direct complication rate was 20%. In another series Alon Burg et al[16] reviewed 60 patients of GSW with 30% overall complications. According to Aspenthal et al.[17] Overall infection rate of war related injury was 25% and it may increase upto50% depending on injury severity and was often associated with Multi Drug Resistant bacteria like

MRSA. In our series 79% patients were treated as outpatients and the infection rate was4% with wound irrigation and marginal excision group and 16% with aggressive wound debridement group. All infections were superficial and responded well with antibiotic. Overall complication rate was 30%. Although we used antibiotics in all cases, our infection rate was high in comparison to Ordog et al. This may be due to poor personal cleanliness, unhygienic living condition, irregularity in dressing change and antibiotic intake, making the dressing dirty and poor nutritional status. Moreover, among late reported (after 24 hours) patients, 04 patients reported with already infected wound. Above all the decision making dilemma as to which wound and up to what extent should be debrided may play a part. It was better to be on the side of aggressive excision rather than to be conservative.

There is no dogmatic treatment of choice for gunshot fractures1. It ranges from "low tech"[1] splintage to "high tech" intramedullary nailing. Choice varies with degree of contamination; site, pattern and comminution of fracture, degree of soft tissue damage, open displaced intraarticular fracture and open fracture associated with neurovascular damage. In a series Alon Burg et al.[16] reviewed 60 patients of GSW with 60% fractures, 8% of which required primary internal fixation and external fixator was most frequently (36%) used fixation modality. In our series 21% patients had fracture, 6% of that required primary fixation, conservative fracture treatment with POP cast was the most commonly(15%) used treatment regime. Our result doe not coincide with that of Alon burg et al. This difference may be due to the nature of injury that we encountered.

Nerves and vessels passes in close relation to bone. So in case of fracture, neurovascular injury is to be excluded. In a study Alon Burg et al.[16] reported16.8% nerve injury with majority (38%) of them belongs to deep peroneal nerve and 08 vascular injuries in 60 patients. In our series we encountered only one bleeding vessel that was torn profunda femoris vein. We got 7% nerve injury and deep peroneal nerve was (5%) which was the most commonly affected nerve.

Complications and outcome:

In our series the overall complication (Fig-III) rate was 30% which correlate with that of Alon Burg et al.The most common complication was wound infection (20%). 70% patient returned to normal life and activity within o6 weeks, Rest 30% have returned to work with some limitations and modifications of life style.

Conclusion: War surgery is always difficult because both the patients and doctors are in adverse situation and resource constraints usually compound the problem. However according to the laid down criteria and by dint of clinical knowledge and experience the wounds can be properly grouped and treated by debridement and irrigation. This result in shorter hospital stays and can avoid unnecessary overzealous debridement and thereby expedite recovery. Above all, in a war situation a surgeon have to balance between professionalism and austerity to achieve good result.

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