Research Article

Long bone complicated non –united fractures, view of management using conventional external fixator & bone graft

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Abstract

Background: The surgical treatment of long bone non-union always represents a critical situation for the orthopedic surgeon than treatment of the primary fractures, especially those complicated fractures that were previously treated more than one time by different methods. As it is necessary not only to refresh & "revitalize" the non-union area, but in need to replace the bone fixation devices and to place a new good amount of autogenous bone graft in the bone gap.

Patients & method: This prospective Study was conducted in orthopaedic department of Al-YARMOOK TEACHING HOSPITAL & IRAQI RED CREASCENT SURGICAL HOSPITAL from (January 2000 till December 2009) on 66 patient (38 tibia,16 feumer,12 humors) ,(23 femal & 53 male) with age range between (18-48 years), presented with (40%hypertrophic non –union , 32%oligotrophic & 28% atrophic non-union) were treated with surgical exploration & refreshing of the sclerotic end of the fracture , removing of soft tissue interposition , opening of the closed intra medullary canal, used of copious autogenous cortico-canllous bone graft from iliac bone, after fixation of the fractures by unilateral frame double barr external fixation.

Results: management by bone graft & external fixatior used in the treatment of hypertrophic ,oligotrophic & atrophic non united long bone result in (86% excellent result) ,(12 % good result) ,(3%fair result) ,(1% poor result).

Conclusion: usage of external fixation + refreshing the fractures end + opening the intramedullary canal +removing of the soft tissue interposition+ used of copious autogenously cortico-canllous bone graft from iliac bone, is an excellent methods for management of long bone non united complicated i.e with previous one or more trial for fixation & treatment but of disastrous effect

Key words: External fixation, Long bone fracture ,Non-union ,Bone graft

INTRODUCTION

Long Bones nonunions still forming a complicated obstacle for the orthopedic surgeon to solve, as it has a high percent of morbidity, in addition to its functional deficits in the patient activity .(1), and it definitely need multiple surgical sections for he management . Although the exact causes of delayed union and nonunion are unknown, A larg number of lab-experimental and clinical research's have stated that the basics for strong & successful bone-healing are first (Good osteosynthesis of the fracture that insure biomechanical stability) and second(good blood supply of the bone that insure bone viability),both of them provide an excellent atmosphere for the new bone to

issue , also we have systemic and local factors that may contribute to this process . the Systemic factors include ;- the patient's general health, his metabolic & nutritional phase , & his daily activity schedule (1)(2) (3). Smoking was found to be one of the factors that also has an influences in bone heasling leading to nonunion . Castillo et al. found that nicotine decreases blood vessel invasion at fracture sites besides it increased the risk of osteomyelitis by increasing the risk of bone necrosis.

. Local factors were express in a clinical review by (Boyd, Lipinski, and Wiley) at there clinic for 842 patients with nonunions of long bones, they found that nonunion increases in (1) compound fractures (2) fractures associated with infection (3) multiple fractures with segmental piece usually had a poor blood supply (4) massive trauma with big soft tissue loss & comminuted fractures (5) inproper fixation(6) inadequate time for immobilization (7) management by unwisely open reduction (8) iatrogenic distraction as by plat& screw fixation or by traction (9) finally if the fracture bone were irradiated.

Different methods to decrease the risk of fracture non-union are applied now , it Depend on the site, degree & type of the fractures non-union, the plane of treatment depend on different methods of bone fixation, with or without additional autogenous bone graft and other bone healing enhancements biophysical methods . The basic role in treatment of non-union or delayed union is the autogenously bone grafting, which offer the osteogenic, osteoinductive, and osteoconductive components necessary for bone regeneration. (3)

Nonunion of a fracture;-is a fracture that show no sign of union in 6 - 9 months with or without surgical or nonsurgical interferences (1,2).previously the definition of delayed union and nonunion were based mainly on duration (time factor) from the onset of trauma .recently time factors plus the sign of progressive bone healing in monthly radiographic studies6-9 months were consider in deciding bone healing & establishing of non-union.

The condition of bones non-union, depends mainly on the site, type and duration of the fracture and how it was previously manage . Judet and Judet, Müller, and others classified (nonunions into two types depending on blood supply & the viability of the both fractures ends. (1,2)

In Type one ;- A hypervascular (hypertrophic) non unions in which there is a viable bone or bone that is capable for biological activation & union. In Type two;- The Avascular (atrophic) non unions in which the bone are unviable incapable for a biological activation for union without additional intervention

Non union's according to Weber-Cech classification (Weber, 1976).depends mainly are on X-ray appearance for classification , that link to fracture healing process and as follows:

- Hypertrophic nonunion;-are fractures nonunions with a vast callus surrounding fractures ends . They are viable -vascular with a very good chance of healing when manage properly .the main cause for non-union is insufficient stabilization (immobilization) of the fractures.
- Atrophic nonunion: - were no sign of callous formation at the devitalzed bone end of the fractures ,these ends could be sclerotic ,tapered & osteoporotic . bone blood supply is deficient, with low healing potential. Atrophic nonunions have a special subgroup ;- those nonunions were a fibrous capsule surrounding a easily mobil fracture bone end. This capsule usually filled with a viscous fluid, forming a false joint, and is referred to as a bone pseudoarthrosis.
- Normotrophic(oligotrophic);- nonunions that show both the atrophic and hypertrophic sign's of nonunions. Where the bone ends show moderate healing activation process .

PATIENTS & METHODS

This is a prospective Study, were conducted in the orthopaedic department of (Al-YARMOOK TEACHING HOSPITAL) &(IRAQI RED CREASCENT SURGICAL HOSPITAL) from (January 2000 till December 2009),,, on 66 patient's (38 tibia,16 feumer,12 humerus) with fractuers of the long bones due to, exposure to terrorist attack explosion wave +shells of explosion bomb, sniper shoot, ,roads traffic accident ,,,falling from height ,, (23 female & 43 male) with age range between (18-48 years average 37.years), all of these cases were treated previously by different methods ,either by simple p.o.p cast in 32% of the cases ,or external fixation in 33% 0f the cases,28% were treated by internal fixation either by normal or DCP. Plat & screw. Or 7% by non –locking intra-medullary k-nail . ….i.e these cases were complicated by non-union after one or more than one trials were applied for treatment previously .the period of non –union were between 6-12 months) average 9 months ,,presented with (hypertrophic non –union in 40% of cases,, oligotrophic non union in 32% of the cases & atrophic non-union in 28% of the cases) ,our methods of treatment consist of the fellowing:-

1) Surgical exploration of the two ends of the fractures at the non united site trying not to strip too much of the covering periostum & not to damage more of the surrounding soft tissue.

2) Start decortications of both ends of the fractures non united ends ((refreshing of the sloretic end of the fracture)) ,keeping most of the callus detached from the bone shaft attached to the periostum.*(3,4)*

3) Then we remove the soft tissue interposition in the bone non united site , opening of the closed intra medullary canal using a drilling perinea or curate.

4) Fixation of the non –united fractures by monolateral external fixation. With one or double barr ,using 6-8 schans pins either ordinary type of external fixation or compression type.*(4,5,6)*

5) Use of copious amount of autogenic cortico-cancellous bone graft from iliac crest one or both sides of the pelvic crest ,especially in cases were a large amount of bone graft is needed to full the non –union bone gap(*7 ,8,9)*

6) In some cases of non-united tibia, an osteotomy for the fibula is indicated to increase the stress on the non-united fracture site. *(10, 11)*

These cases were followed by X-Ray monthly , also followed by clinical observation of the operated limb, the external fixation pins opening ,these procedure done for at least (4- to 12) months.

RESULT

The result were included in the master chart in the table (1). Management of the cases with the external fixation + bone graft ended with the fellowing result according to (Johner and Wruh's Criteria) were (53cases excellent result) ,(8 cases good result) ,(4 cases fair result) ,(1case poor result).Table (2)

Table 1:- Master chart of results.

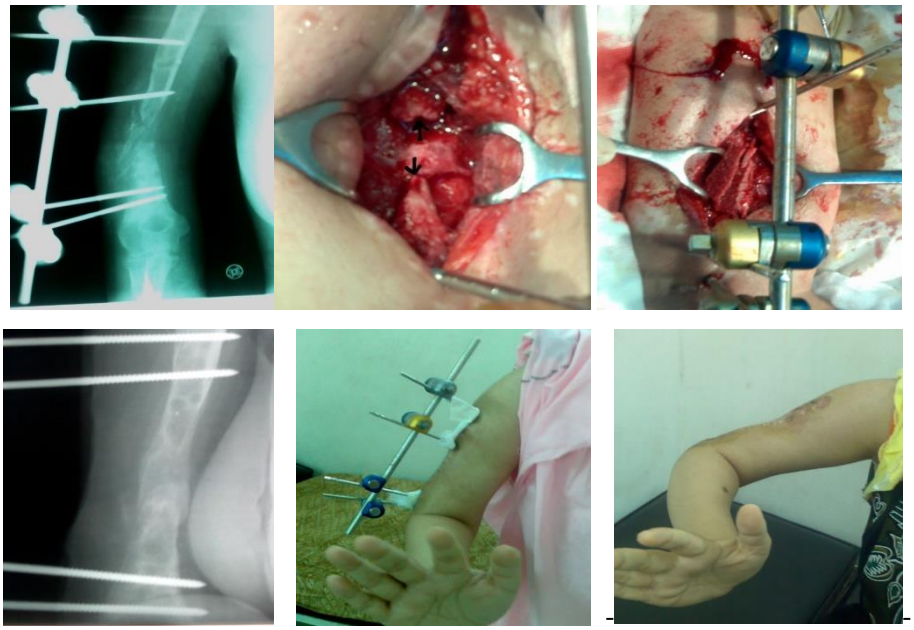
Case	Age	Sex	Bone #	X –Trial For # Union	Type Of Non U.	Result	Union Period
1	23	Male	Tibia	External Fixation	Hyper Tropic	United	6 Months
2	30	Male	Tibia	External Fixation	Hyper Trophic	United	6 Months
3	42	Male	Tibia	Internal Fixation	Atrophic	United	4.5 Months
4	33	Female	Tibia	Cast Of Pop.	Oligotrophic	United	5 M0nth
5	21	Male	Tibia	External Fixation	Oligotrophic	United	4 Months
6	37	Male	Humrs	Internal Fixation	Oligotrophic	United	6.5months
7	48	Male	Femr.	External Fixation.	Hyper Trophic	United	6 Months
8	33	Female	Tibia	Internal Fixation	Hyper Trophic	United	6 Months
9	21	Male	Tibia	Internal Fixation	Atrophic	United	4.5 Months
10	19	Male	Tibia	External Fixation	Oligo Trohpic	United	5 Months
11	42	Female	Humrs	Cast of Pop.	Atrophic	United	7 Months
12	37	Male	Femr.	K-Nail	Hyper Trophic	United	8.5 Months
13	25	Female	Femr,	Internal K-Nail	Oligotrophic	United	6 Months
14	47	Male	Tibia	Cast of Pop.	Hyper Tropic	United	7. Months
15	17	Male	Tibia	Cast of Pop.	Hyper Tropic	United	6 Months
16	30	Male	Femur	Internal Fixation	Atrophic	United	6 months
17	23	Female	Tibia	External Fixation	Hyper Trophic	United	5months
18	30	Male	Tibia	External Fixation	Hyper Trophic	United	7 Months
19	42	Male	Tibia	Internal Fixation	Atrophic	United	6 Months
20	33	Female	Tibia	Cast Of Pop.	Oligotrophic	United	6 M0nth
21	21	Male	Tibia	External Fixation	Oligotrophic	United	6 Months
22	37	Female	Humrs	Internal Fixation	Oligotropic	United	4months
23	48	Male	Femr.	K-Nail	Hyper Tropic	United	5 Months
24	33	Female	Tibia	External Fixation	Hyper Tropic	United	6 Months
25	21	Male	Tibia	External Fixation	Atrophic	United	4.5 Months
26	19	Male	Tibia	External Fixation	Oligotrophic	United	5 Months
27	42	Female	Humrs	Cast Of Pop.	Atrophic	United	7 Months
28	37	Male	Femr.	K-Nail.	Hyper Tropic	United	9 Months
29	25	Female	Femr,	K-Nail	Hyper Tropic	United	5 Months
30	47	Female	Humrs	Cast of Pop.	Hyper Tropic	United	6 Months
31	18	Male	Tibia	Cast of Pop.	Hyper Tropic	United	4.5 Months
32	44	Femal	Humrs	Internal fixation	Atrophic	United	7 months

33	23	Male	Tibia	External fixation	Hyper Tropic	United	6 months
34	30	Male	Tibia	External fixation	Hyper trophic	United	5 months
35	42	Male	Femur	Internal fixation	Atrophic	United	7.5 months
36	33	Female	Tibia	Cast of pop.	Oligotrophic	United	6 m0nth
37	21	Male	Tibia	External fixation	Oligotrophic	United	6 months
38	37	Male	Humrs	Internal fixation	Oligotrophic	United	6months
39	48	Male	Femr.	Cast of pop.	Hyper Tropic	United	5.5 months
40	33	Female	Tibia	Cast of pop.	Hyper Tropic	United	6 months
41	21	Male	Tibia	External fixation	Atrophic	United	4.5 months
42	19	Male	Tibia	Cast of pop	Oligotropic	United	5 months
43	42	Female	Humrs	Cast of pop.	Atrophic	United	5.5 months
44	37	Male	Femr.	Cast of pop.	Hyper Tropic	United	6 months
45	25	Female	Femr,	Internal.fix.	Oligotrophic	United	6 months
46	47	Male	Tibia	Cast of pop.	Hyper Tropic	United	7.5 months
47	17	Male	Tibia	Cast of pop.	Hyper Tropic	United	6 months
48	28	Female	Tibia	External fixation	Atrophic	United	6 months
49	23	Female	Femur	External fixation	Atrophic	United	6 months
50	30	Male	Tibia	External fixation	Hyper trophic	United	8 months
51	42	Male	Tibia	Internal fixation	Atrophic	United	7 months
52	33	Female	Tibia	Cast of pop.	Oligotrophic	United	6 m0nth
53	21	Male	Humrs	External fixation	Oligotrophic	United	6 months
54	37	Male	Humrs	Internal fixation	Oligotropic	United	6months
55	48	Male	Femr.	Internal fix..	Hyper Tropic	United	4.5 months
56	33	Female	Tibia	Cast of pop.	Hyper Tropic	United	6 months
57	21	Male	Tibia	Internal fixation	Atrophic	United	4.5 months
58	19	Male	Tibia	External fixation	Oligotropic	United	5 months
59	42	Female	Humrs	Cast of pop.	Atrophic	United	7 months
60	37	Male	Femr.	Internal fixation	Hyper Tropic	United	5.5 months
61	25	Female	Femr,	Internal ifx.	Atrophic	United	5 months
62	47	Male	Tibia	Cast of pop.	Hyper Tropic	United	6 months
63	17	Male	Tibia	Cast of pop	Hyper Tropic	United	4.5 months
64	37	Female	Humrs	Internal fixation	Oligotropic	United	5months
65	48	Male	Femr.	External fixation	Oligotrophic	United	6 months
66	33	Male	Tibia	External fixation	Atrophic	United	6 months

Table 2: Johner and Wruh's Criteria for evaluation of final results

Criteria	Excellent	Good	Fair	Poor
Non union/infection	None	None	None	Yes
Neuro-vascular injury	None	Non	Moderate	Severe
Deformity				
Varus/valgus	None	2-5	6-10	>10
Pro/recurvatum	0-5	6-10	11-20	>20
Flotation	0-5	6-10	11-20	>20
Shortening	0-5mm	6-10mm	11-20mm	>20mm
Mobility				
Knee	Full	>80%	>75%	<75%
Ankle	Full	>75%	>50%	<50%
Subtler	>75%	>50%	>50%	
Shoulder &elbow	Full	>80%	>75	
Pain	None	Occasional	Moderate	Severe
Gait	Normal	Normal	Mild limp	Significant
Activity & Strenuous	Possible	Limited	Severely limited	Impossible
Study results	53	8	4	1

Examples for the cases



(Case No.1) Fracture Lt. lower humerus due to terrorist explosion treated first by ext.fixation ,ended by atrophic non-union ,treated by bone graft, refreshing sclerotic non-united end, opening bone marrow canal , fix by external fixation, full union in 6 m.

(CASE NO.2) comminuted fractures of upper tibia due to RTA treated previously by external fixation for (8 months)& ended by atrophic non – union ,bone graft + external fixation for 6 months & full union establish

(Case No.3) Oligotrophic non union of the lower tibia & fibula due to RTA.after (8) months ago treated by serial pop. Casting ,treated by ext.fixation + bone graft full union in 6 months .-

(Case No.4) fracture femur treated by k-nail + circumflexes wire for 6 months ,ended by atrophic nonunion after early removal of the k-nail, external fixation + bone graft full union in 6.5 months

(Case no.5) hyper trophic non union mid tibia after internal fixation by plat & screw, plat removed .fibula osteotomy external fix,+bone graft.,full union in 4.5 months.

(Case No. 6) fragmented close fractures feumer treated first by plat & screw ,ended with atrophic non un. & metal fatigue, replace by external fixation & bone graft, full union in 6, 5 months

DISCUSSION

Expertise/competence of the surgeon, proper working condition , & proper approach & proper selection of a good quality implant & proper selection of fixation technique, favor the fracture union ,while compromise on any of the above factors result in a disaster to the patient,

Different surgical methods with different kinds of Autogenous or allogenous bone graft materials used to full the bone gap, were reported & published for the treatment of long bone nonunion ,in addition to cretins biological principles should be followed in the management of non-united fractures which summarized as follows8

(i) Excision of the of the fibrous tissue crossing the gap of non union.

(ii) Opening the blocked obliterated bone marrow canal plus proper reduction of the fracture

(iii) osteogenesis Stimulation by bone graft mainly

(iv) Rigid fixation or immoblization of the fracture (by external fixation (either circular fram or a monolateral plane) by (rigid osteosyntheesis using plat &screw , intra-medullary ordinary or the more recent locked nail).

(v) management of of extensive soft tissue damage & further necrosis of bone & soft tissue

According to *Urisf*, *Mazet* & *McLean* (1954) in established non-unions the resection of the **. Excision of the of the fibrous tissue crossing the gap of non union.is an essinational steps as this fibrious tissue acts as a barrier block to the osteogenetic materials spreading from from the periosteum & endosteum stopping them from crossing the bone gap .*(3.4)* to form the callous & the immature new bone formation

** Opening the blocked obliterated bone marrow canal plus proper reduction of the fracture is also an essential factor in the management of a non-union ,,the tapered sclerotic bone end of the fracture non-union act as a blocking agent to the endosteal active substance from crossing their osteogcnctic activity . excision of the sclerotic bone end improve a blood vessel circulation and help the endostcal osteoblasts to pass cross over the bone gap which enhance healing process.

**Bone transplation((cortico –cancellous autogenous)) for the stimulation of the healing of the non-united fractures is the golden cornerstone in our procedure.

Autogcnous 'transplaned compact bone is used by the host as a network for the new bone strictures , as it's replaced slowly by laminar immatuer bone provided by a active proliferative reaction of the osteogenetic materials of the host (*Urist rt nl.*, 1954*).(9,10,11)*

** Rigid fixation for immmoblization of the end bone fragments has unique importance in the management of recent fractures than in non-union. rigid fixation for immobilization ,using internal or external fixation is essential for the callus & new bone formation to establish(primary bone healing) ,we found that internal fixation may be more rigid in fixation ,but it carries higher risk of excessive stripping of the periostum to expose the non united site ,,which is very difficult sometimes due to big scar tissue in the skin & extensive soft tissue adhesion around the injured area ,,,this will cause more harm to the surrounding soft tissue, increasing the risk of soft tissue necrosis & non-union , taken in consideration that large number of these cases were caused primarily by high speed velocity shell or missile leading to a compound fracture carrying a high risk of infection & osteomylitis with the risk of presence of huge amount of tiny shells inside the soft tissue surrounding the fractures site as a source of infection , all this lead us to use the external fixation device as a methods of stabilization,,(((usually the mono-lateral plan, double barr with 6-8 schanz pins.)) in addition to that ,,external fixation help in providing a micro-movement at the non –union site &help In doing dynamization later in the final stage of the fractures healing ,,which help in strengthening the new callus formation .(6,11)

Conclusion

The author see that non union is a problem of mishandling the fractures issue from the beginning ,in addition to multiple contributing surrounding factors, treating of a different types of the non-unions, by copious amount of autogenes cortico -cancellous bone graft, in addition to refreshing of the sclerotic non-union ends & opening of the obliterated bone marrow canal & using a mono lateral external fixation with double barr for fixing the fractures across the nonunion site, is a good methods for treating the problems of nonunions as we proof in this study that around 96% of the cases ended with excellent to good result.

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