PARTIAL WEIGHT BEARING; NEW QUANTITATIVE APPROACH

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ABSTRACT

Objective: The objective of this study was to quantify scientifically the partial weight bearing advice to the patients so that the treating surgeons and treated patients know exactly how much weight they should bear on the treated limb.

Study design: Descriptive study.

Duration and Place; The study was conducted at combined military hospital Sialkot and combined military Hospital Quetta from May, 2003 to Dec, 2006.

Patients and Methods: We studied 150 patients who were operated for osteosynthesis in lower limb. We excluded all patients below age 10 years, poly trauma patients operated for bilateral leg fractures, and associated upper limb fractures. Patients were advised to place studied limb on weighing machine and exert required force. Depending upon implant used, quality of fixation and bone density, 5 to 10 kilogram of weight bearing was started two to three weeks after the operation. This force was gradually increased by 5 to 10 kilograms two weekly interval as union progressed.

Results: Average age of the patients was about 40 years most of them were young males, with 5:1 ratio to females. Femur was most commonly involved bone in 81 (54 %) patients, while tibia in 69 (46%) patients. Road traffic accident was most common etiology in 95 (63.33 %) patients, history of fall, nonunion, and field injuries were etiology in other cases. Locally made implants were used in all cases. External fixator was applied in 45 (30%) and internal fixation was done in 105 (70%) cases. Bone grafting was done in 24 cases. We achieved union in 97.3% patients. Union was achieved in mean 15.1 weeks in internal fixations and 17.3 weeks in external fixators. We had 21 (14%) minor and 8 (5%) major complications most of them in patients requiring external fixators.

Conclusion: Quantifying partial weight bearing advice gives confidence to patient that how much weight bearing to be done depending upon fracture geometry, implant used its fixation and bone quality. By avoiding nonspecific terms toe touch, heel touch and partial weight bearing we can advise exactly to bear required weight by this simple method. The result of study shows excellent union rates even in open fractures and infected nonunion.

To our knowledge this is the first attempt to quantify partial weight bearing advice. The result of this study will help in understanding the patient regarding weight bearing.

Keywords; Partial weight bearing, Quantitative weight bearing, weighing machine

INTRODUCTION

Weight bearing is very important for callus formation during fracture healing. Weight bearing increases the formation of bone in fracture healing and lack of weight bearing decreases the amount of woven bone that is formed in healing of fractures [1]. Weight bearing is essential for articular cartilage regeneration. Weight bearing is also helpful in preventing deep vein thrombosis. Movements of the ankle and weight bearing improve venous peak velocity and aid in thromboprophylaxis [2]. Factors that did adversely affect stability following fixation, include the degree of initial comminution and displacement of the fracture, failure to adequately reduce or fix the fracture, and severe demineralizing of bone [3].

Fracture healing depends upon systemic and local factors. Multiple patient factors have been shown to contribute in delayed union and nonunion of fractures. One of them is malnutrition, which often goes unrecognized. Adequate protein is required for healing, and inadequate caloric intake has been shown to contribute to delayed union and nonunion [4]. Cigarette smoking has been shown in numerous clinical and experimental studies to have an adverse effect on fracture healing. Although the exact mechanism remains

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unclear, nicotine consumption and cigarette smoking have been shown to have deleterious effects on local vascularity and cellular function at the fracture site [5]. Infection prevents union at fracture site. The soft tissue dissection and, disruption of the bone blood supply by the plate-screw-bone construct should be minimized to promote callus formation. Stable fixation is essential for fracture healing. The implant used must resist physiological loads to allow fracture union by limiting fracture gap stress, provide sufficient stability to permit early limb motion, and not fail before fracture union occurs [6].

Early weight bearing is beneficial for fracture healing [7]. Bone grafting enhances union after mechanical stability has been addressed. Bone formation is a process consisting of osteogenesis, osteoinduction, and osteoconduction [8]. There is an increased osteogenic potential and an enhancement of fracture healing secondary to traumatic brain injury [9].

Surgeons always advise their patient for weight bearing. The advice is different for each fracture and varies depending on the patient's condition and the stability of the internal fixation. Hardware failure is not uncommon problem, many authors have observed failure of screws. Failure at the screw-plate interface, screw loosening and screws breakage soon after weight bearing has been reported [10].

Osteopenia complicates fracture treatment and healing. Stable internal fixation is the fundamental principle behind modern operative fracture care, as it permits early range of motion and weight-bearing on the extremity while maintaining fracture reduction. It is more difficult to obtain stable internal fixation with use of hardware in osteopenic bone. Osteopenia results in poor screw purchase and increased risk of screw pullout from the bone, leading to fixation failure (11). The threat of fixation failure often results in prolonged immobilization following operative treatment, which in turn can cause "disuse osteopenia," further complicating fracture treatment. The periprosthetic fractures around total joint replacements or other orthopaedic implants are challenging. Fortunately, these fractures are relatively rare with a frequency reported as low as 0.4% to as high as 7.8%. They occur more frequently in women than in men [12].

The partial weight bearing is begun, by using a walker or two crutches. This advice is qualitative and nonspecific like toe touch, weight bearing, heel touch weight bearing, partial weight bearing. The advise to the patients regarding weight bearing in international literature is partial weight bearing till union is achieved [13], toe touch, heel touch and weight bearing as tolerated [14]. The patients are advised similarly for external fixators [16]. In domestic literature same advice of partial weight bearing with crutches or walking frame is used for internal fixation [16]. For external fixator partial weight bearing has been advised similarly [17]. These qualitative and nonspecific terms do not explain how much weight patient should bear to load injured leg, causing confusion for patients and stress to implants.

We attempt to quantify weight bearing advice using weighing machine. With this simple method surgeon and patient both knew that how much weight bearing is to be done by the patient depending upon fracture geometry, implant used and fixation strength.

The objective of this study was to quantify scientifically the partial weight bearing advice to the patients so that the treating surgeons and treated patients know exactly how much weight they should bear on the treated limb.

PATIENTS AND METHODS

The study was conducted at department of orthopedics Combined Military Hospital Sialkot and Combined Military Hospital Quetta. We included patients requiring osteosynthesis of femur and tibia and excluded patients below 10 years of age, and poly trauma patients with associated upper limb fractures and bilateral lower limb fractures. 150 patients were included in this study. The period of study was May, 2003 to Dec, 2006. The selection of patients was done by non-probability convenient sampling from orthopedic

department. Detailed counseling about the nature, purpose of procedure was done and written consent was obtained in all cases. Then they were asked if they were interested to be included or not.

All patients were operated by single Surgeon. Locally made implants were applied in all cases. Orthopedic traction table and image intensifier were used in closed interlocking nailing, dynamic hip screw and dynamic condylar screw application. Dynamic compression plating and External fixations were applied on orthopedic operation table with radioleucent top and image intensifier was used whenever required to see hardware position per operatively. Nonunion were excised and bone grafting was done to fill the cavity and defect (Fig.1). No external splintage was used in dynamic hip screws, interlocking nails and external fixators. When dynamic compression plates were applied, Plaster of Paris back slabs support was used for two to three weeks. After operation antibiotics were given according to etiology from 2 to 21 days. Closed suction drains were placed for 3 days in clean cases, 10 to 14 days in open fractures and 14 to 21 days for infected cases. The patients were allowed to sit in a chair the day after surgery, and active exercises of the upper and lower extremities were begun. Depending on the patient's condition and the stability of the internal fixation, partial weight-bearing was begun using a walker with our set protocol.

We used weighing machine to educate our patients for partial weight bearing. We advised them to place foot on weighing machine and see the desired weight bearing on machine by exerting pressure according to implant used, adequacy of fixation and quality of bone (Fig.2). When they were educated regarding pressure applied by the foot and weight bearing shown by machine, we advise them to apply same pressure during walking. This was gradually increased 5 to 10 kilograms two weekly intervals till full weight bearing was achieved, which depended upon each case individually. It was ensured that quantitative weight bearing advice was understood by patients by asking the patient to exert pressure multiple times equal to what was desired.

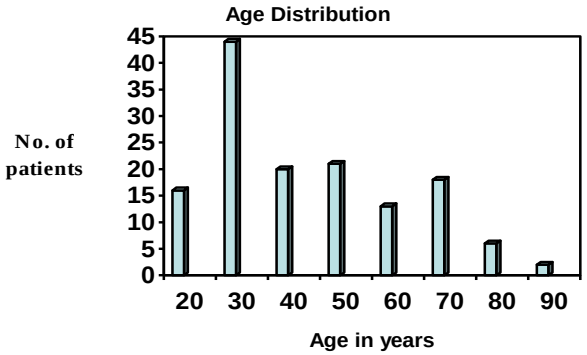
RESULTS

150 patients requiring osteosynthesis were studied. Average age of the patients was 40.14 years. The age range was 11 to 87 years, most of them were young males, 74 (49.3%) belonged to third and fourth decade (Fig. 3). Only 26 (17.3%) were females. Femur was most commonly involved bone in 81 (54 %) patients, while tibia in 69 (46%) patients. Road traffic accident was most common etiology in 95 (63.3 %) patients, history of fall in 26 (17.3%), nonunion in 15 (10%) and gun shot wound and mine blasts were etiology in 14 (9.3%) cases. Locally made implants were used in all cases. . Bone grafting was done in 24 (16%) cases. We divided our patients into two groups for convenience. Group1 include patient needing internal fixation implants and group II included patient requiring external fixator.

Group 1; 105 (70%) patients required internal fixation, their average age was 42.6 years. 83 (79%) were males and 22 (21%) were females, in 75 (71%) patients femur and in 30 (29%) cases tibia was involved. In 36 (34.3%) dynamic hip screw, 35(33.3%) dynamic compression plate, 23(21.9%) interlocking nail, 10 (9.5%) 95 degree dynamic condylar screw and in one (1%) case cancellous screw was applied (Tab. 1). We achieved union in 103(98.1%) cases in mean 15.1 weeks with minimum 12 weeks and maximum 19 weeks (Fig. 4). We had two (1.9%) major and eight (7.6%) minor complications in this group. Two (1.9%) of our patient had nonunion in femoral fractures. One interlocked nail had nonunion because of opening of fracture due to failed closed technique and was treated with bone grafting (Fig. 5). One dynamic compression plate failed and was re-operated with new plate with bone grafting. Both of these fracture healed uneventfully thereafter. 3 interlocking screws breakage (Fig. 6), 2 knee joints got stiff and 3 dynamic hip screw union in shortening were minor complications.

Group 2: 45 (30%) patients requiring external fixation were include in this group. Average age of the patients was 33.35 years.

Figure- 3: Age Distribution of Patients



Partial Weight Bearing

The age range was 12 to 65 years. 23 (51%) of them were in third and fourth decade of life. We had predominantly 41 (91%) male patients, only 4 (9%) were females. Tibia was mot commonly involved bone in 39 (86.7%) patients (Fig. 7), while femur was affected in 6 (13.3%). Road traffic accident was most common etiology in 33 (73.3%) patients either presenting as open fractures or infected nonunion. We achieved union in 43 (96%) cases. The mean external fixator time was 17.3 weeks, with maximum 48 weeks and minimum 7 weeks. We had 6 (13.3) major. Two cases remained nonunited needing further surgery in three patients, we had to remove and change 3 broken Shanz screws and in one case tendoachillis lengthening had to be performed for severe equinus. We had 13 (28.9%) minor complications that included 9 pin tract infections and 4 joints stiffness. We had excellent results when fixators were applied to tibia as compared to femur, where we had good results.

Table: Frequency of different implants

S/No	Implant	Number of patients	Average age (Years)	Mean union time (Weeks)
1	External fixator	45	33.35	17.3
2	Dynamic hip screw (DHS)	36	50.53	14.8
3	Dynamic compression plate (DCP)	35	30.42	14.77
4	Interlocking nailing	23	35.39	13.86
5	Dynamic condylar screw (DCS)	10	43.40	15
6	6.5 mm cancellous screw	01	33	16

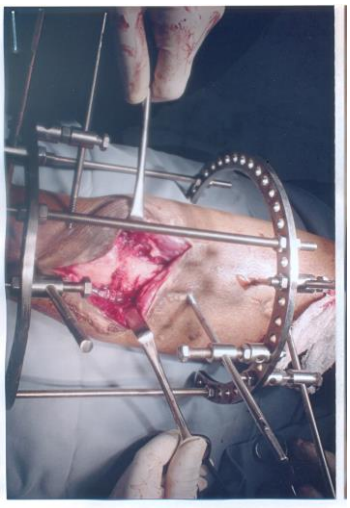


Fig-1: Cancellous bone grafting.

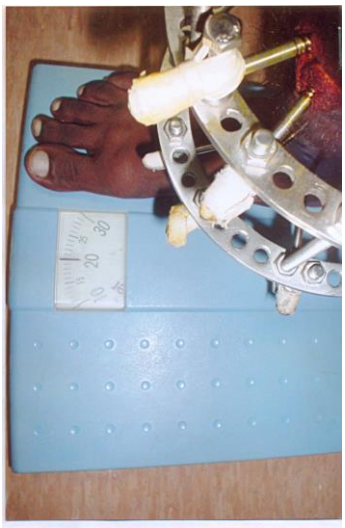


Fig-2: Quantitative weight bearing 20 kilogram.

DISCUSSION

Fig. 4: Union achieved in 10 weeks

Fig. 5: Union achieved after iliac crest bone grafting.

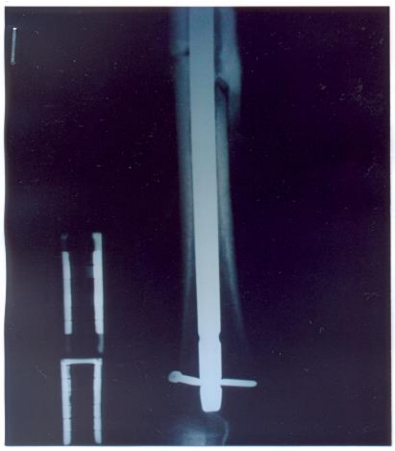


Fig. 6: Broken interlocking screw.

Fig. 7: Open segmental fracture tibia.

Weight bearing is important for fracture healing, cartilage regeneration. It is also important for soft tissue function and prevents deep vein thrombosis [2]. Weight bearing advice for fracture of lower limbs and other problem has been qualitative and non specific like toe touch, heel touch, partial weight bearing [12] and bearing to tolerance, and there is no guideline for patients. Since patients seem to control weight bearing themselves the effect in normal bone with adequate fixation are not catastrophic [18]. But in osteoroporotic bones and in inadequate fixation it becomes important for fracture healing. The functional results of treatment of pertrochanteric fractures are often unsatisfactory. The results are influenced by the inability of the implant to remain well fixed in osteoporotic bone during the time required for fracture healing. Implant failure and loss of reduction, which often lead to fracture malunion, are frequent complications of osteoporotic pertrochanteric fractures. Because fracture stability is crucial for bone repair, poor bone quality remains a concern that must be given priority when the type of implant is being chosen. If stable fixation is achieved, early rehabilitation can be instituted [19]. We achieved 100% union rate in 36 Dynamic Hip Screw fixation, only in 3(8.3%) patients fracture united in shortening. In a study conducted Hamilton General Hospital the authors noted 9.58% nonunion in 73 patients [20].

We achieved union in 15.1 weeks in internal fixations. In a study conducted at Mayo hospital Lahore, the authors noted mean union time of 18.9 weeks for open and 14.4 weeks for closed fractures of femur using interlocking nail [16]. The authors advised their patient touch down ambulation, partial weight bearing and

full weight bearing at callus formation at fracture site. They advised delayed weight bearing in case of comminution. They reported 10% nonunion and one screw breakage in forty patients. In interlocking nailing we achieved union in (96%) of patients. In one patient nonunion resulted from failed closed technique. We had three (13%) interlock screw broken in 23 patients. We had only one (2.8%) Dynamic compression plate loosening in 35 patients. Other authors have also observed failure with broken screws at the screw-plate interface, and in some cases loosening of locked screw heads. In these cases, screw breakage after weight bearing was initiated [10].

We achieved union in 17.3 weeks in external fixators. In a study performed in specialized center the authors noted mean time to union of 28 weeks using external fixators [2].

CONCLUSION

We devise very simple method to quantify and specify the weight bearing advice using weighing machine. The advantages are that there is quantitative weight bearing can be used and study has shown excellent union rate in internal fixation as well as good results in external fixation

We recommend quantitative weight bearing in all cases when ostosynthesis or arthrodesis is the goal.

This method especially recommended for fractures in osteoporotic bone, peritrochanteric fractures and inadequate fixation.

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