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Original Research Article

Functional Outcome of Patients with Compound Fractures Managed by Primary Fixation with Plate and Nail

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Abstract:

Background: Participating in sports has a positive influence in many areas. It supports positive mental health and improves social skills along with promoting physical health. Participating in sports develops healthy living habits that provide physical benefits such as developing coordination, physical fitness, and strength. Sports and Exercise reduces the levels of stress hormones in our body. At the same time, physical activity stimulates production of endorphins. These are natural mood lifters that can help keep stress and depression at bay and in this way, sports add up to the happiness too.

Objectives: This Study Aims to assess the effect of participation in sports on the self-esteem and happiness of medical students, and to identify healthy habits developed due to participation in sports among medical college students.

Materials and Methods: This cross–sectional study was conducted between June to November 2022 among 206 randomly selected medical students of age 18 to 26 years of various medical colleges of Central India in Indore District who gave consent, using a pre-designed, pre-tested, semi-structured questionnaire. The questionnaire was constructed based on two scales (Rosenberg self-esteem scale and Subjective happiness scale) for measuring self-esteem and happiness respectively. Data entered in Microsoft excel have been analysed by using SPSS software25.0 (trial version).

Results: In this study 43.2%participants were Males and 56.8% were Females. Among them 49.5% belonged to 20-21 years age and mean age (in years) of participants was 20.89 with S.D. (Standard Deviation) of 1.57. Majority (69.4%) of the participants used to play sports while 30.6% did not play sports. Among those who were playing sports, 44% used to play badminton and 74.1% spent <1 hour/day on sports. 97.9% felt refreshed after playing sports and 97.2% opined that sports have effect on self-esteem and happiness of a person. Mean Subjective Happiness Scale (SHS) Score of participants, those who played sports was 4.823 ± 0.69 (S.D.). Mean SHS Score of participants those who did not play sports was 3.26 ± 0.63 (S.D.). Mean Rosenberg Self-Esteem (RSE) Score of participants those who played sports was 27.00 ± 3.15 (S.D.). Mean RSE Score of participants those who did not play sports was 23.65 ± 2.82 (S.D.).

Conclusion: Subjective happiness scale score and Rosenberg self-esteem score were found to be greater among those who played sports compared to those who did not play sports and both were statistically significant ($p<0.05$).

Keywords: Self-Esteem, Happiness Scale, Sports Participation.

Introduction

Fracture is defined as partial or complete break in the continuity of bone with bone may be broken into several pieces as a result of high force impact or stress [1]. Fractures are classified in various ways. Closed fractures are those in which the overlying skin is intact and open fractures are those in which wound communicate with the fracture as well as fracture hematoma is exposed. Open fractures are fractures that are associated with break in the skin and underlying soft tissue [2]. Open fractures are classified mainly into Gustilo and Anderson's classification and Mangled Extremity Severity Scale (MESS) [3,4,5,6]. Gustilo and Anderson's classification is most widely used classification system which is generally accepted as the primary classification system for open fractures. It takes into consideration the energy of the fracture, soft-tissue damage and degree of contamination. It is

modified from the original classification to allow a more accurate prognosis for more severe injuries [4,7]. Second classification system, Mangled Extremity Severity Scale (MESS) was originally designed as an objective tool for assisting surgeon in decision making for amputation versus limb salvage in complex lower extremity trauma [6]. It takes into consideration the skeletal and soft tissue damage, limb ischemia time, presence of shock and the patient's age.

Aims and Objectives

Aim

To analyze the functional outcome of primary definitive internal fixation (with primary or secondary wound closure) in open fractures-Gustilo Anderson grade II, IIIA and IIIB fractures of long bones with long bones being Humerus, Radius-Ulna, Femur and Tibia.

Objective

To assess functional outcomes in these patients with respect to; 1. Infection (Early or Late) 2. Type of Infection (Superficial or Deep) 3. Skin Complications 4. Hospital stays 5. Time until bone union in weeks 6. Other complications.

- Deep Vein Thrombosis
- Implant Failure
- Non-Union

Methods

Study Design: The present study is a Cross Sectional observation study.

Study Duration: The study was conducted from October 2019 to October 2021

Source of patient

All the patients admitted in the orthopaedic ward of MGM medical college and hospital, Aurangabad, with open fractures of long bones grade II, IIIA and IIIB who fulfil the inclusioncriteria.

Sample Size

N =30

$$\eta = \frac{Z^2 \times p\,(1-p)}{\varepsilon^2}$$

Where p= population proportion 2.779.
Z= z score 1.96 for 95% confidence interval
ε = margin of error 5 %

Inclusion criteria

1. Open fractures of long bones (Humerus, Radius-Ulna, Femur, Tibia) grade II, IIIA, IIIB.
2. Presenting within 48hrs of sustaining injury.
3. Without vascular injury.
4. Patients who can be taken in OT within 12 hours of presentation.
5. Patients who give consent for surgery after counseling.

Exclusion criteria: Patients with Head Injury

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4. Patients who can be taken in OT within 12 hours of presentation.
5. 5.Patients who give consent for surgery after counseling.

Exclusion criteria: Patients with Head Injury

Protocol for study

All patients attending the orthopedic out-patient department and casualty with complaints of an open fracture grade II, IIIA, IIIB and meeting inclusion and exclusion criteria will be selected for the study. A written informed consent will be obtained from selected patients.

1. Patients will be stabilized hemodynamically in the casualty (BLS/ACLS guidelines)
2. X-rays of the injured limb will be taken, and CT-scan will be done if indicated.
3. Patients will be evaluated for pre-op fitness and will be optimized for early surgery (within 12 hours)
4. Appropriate internal fixation in the form of NAIL o PLATE will be done.
5. Antibiotic cement beads to be used wherever necessary.
6. Appropriate primary skin closure with suture if possible or a secondary or delayed wound closure with a flap or graft.
7. Broad spectrum antibiotics which are included:

a) INJ. PIPTAZ 4.5g IV TDS (Piperacillin + Tazobactam) for 5 days
b) INJ. METRO 100CC IV TDS(Metronidazole) for 5 days
c) After 5 days ORAL broad spectrum CEPHALOSPORINS to be administered till suture removal

6. Post op x-ray to be done.
7. Follow-up visits after 2weeks (suture removal), 4 weeks, 6 weeks, 8 weeks, 12 weeks and 6 months after surgery. On each visit X-ray will be done, Skin condition and movements at adjacent joints will be assessed.

Functional outcomes to be assessed at the end of 6 months:

a) Infection (Early or Late).
b) Type of Infection (Superficial or Deep).
c) Skin Complications.
d) Hospital Stay.
e) Time until bone union in weeks.
f) Other complications:

- Deep Vein Thrombosis (DVT)
- Implant Failure

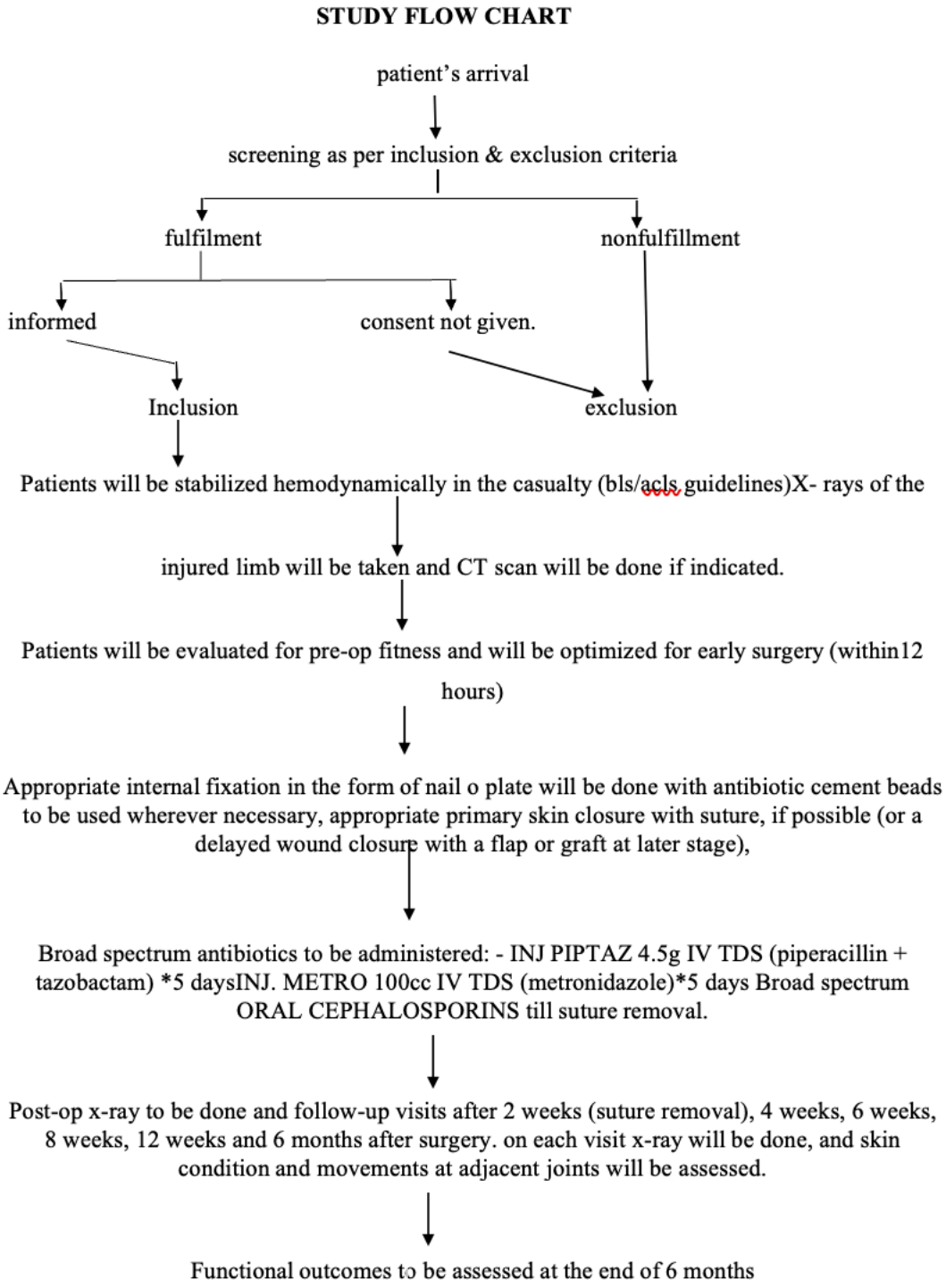
- Non-union

Surgical technique

1. Under all aseptic precautions patient is taken on OT table.
2. Necessary IV antibiotics are administered (preferably IV cephalosporins).
3. Patient is given the required anesthesia (General anesthesia or spinal anesthesia or regional anesthesia).
4. Sterile painting and draping of parts done.
5. First of all thorough wound debridement is done according to the type of compoundwound (Gustilo-Anderson type)[16].
6. Thorough wound wash is given with Normal saline, 5% iodine (betadine) andhydrogen peroxide (H_2O_2) (figure 21).
7. Then the fractured fragments are aligned under fluoroscopic guidance and appropriate method of internal fixation is done (either intramedullary nail or a plate- preferably nail as it preserves the periosteum) (figure 23).
8. Then again thorough wound wash is given with normal saline, 5% iodine(betadine) and hydrogen peroxide (H_2O_2).
9. Primary closure is tried with tagging sutures and if it's not possible then secondary wound closure is planned at a later stage with a flap or a graft (figure 22).
10. Necessary Aseptic Dressing is done, and patient is shifted to ICU or ward wherever necessary.

Figure 1:

Figure 2:



Statistical Analysis

Data collected compiled in MS EXCEL Sheet 2018. Analysis of Data is done by SPSS Software Version 2.0. Qualitative data tabulated in the frequency and percentage form. Quantitative data tabulated in the form of Mean, Median, Mode, Standard deviation, sensitivity, specificity, PPV, NPV. Chi-square test has been used to test the proportions in association. Both Qualitative and Quantitative data represented in the form of visual impression like Bar Diagram, Pie Diagram. Microsoft word and Excel have been used to generate graphs, tables etc.

Chi-Square Test

$$\chi^2 = \frac{\Sigma (Oi - Ei)^2}{Ei}$$

Where Oi is observed frequency and Ei is Expected frequency

Observation and Results

Table 4: Distribution of Cases according to Age

Sr. No.	Age group (Years)	Number of Cases (N)	Percentage (%)
1	< 18	2	6.66 %
2	19 to 30	6	20.0 %
3	31 to 40	9	30.0 %
4	41 to 50	4	13.33 %
5	51 to 60	7	23.33 %
6	>60	2	6.66 %
Total		30	100 %

Majority of the patients belonged to age group 31-40 years (30%), followed by 51-60 years(23.33%), 19-30 years (20%), 41 to 50 years (13.33%) ,< 18 years and >60 years (6.66%)

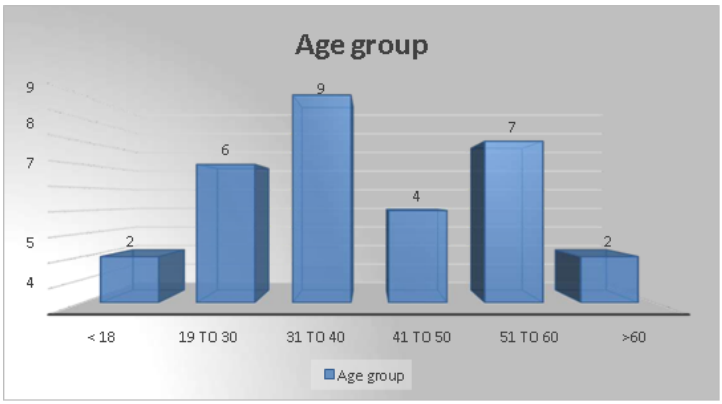


Figure 3:

Table 5: Distribution of Cases according to Sex

Sr. No.	Sex	Number of Cases (N)	Percentage (%)
1	Male	22	73.33 %
2	Female	8	26.66 %
Total		30	100 %

Majority of the patients were males (73.33%) and rest were females (26.66%).

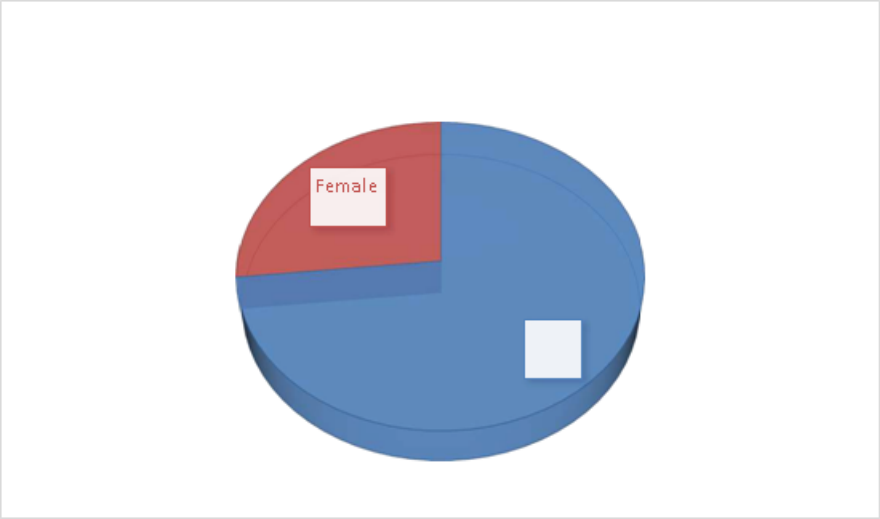


Figure 4:

Table 6: Distribution of Cases according to Co-morbidity

Sr. No.	Comorbidity	Present N (%)	Absent N (%)	Total N (%)
1	Addiction (Alcohol and tobacco)	1 (3.33%)	29 (96.66%)	30 (100%)
2	Hypertension	2 (6.66%)	28 (93.33%)	30 (100%)
3	Diabetes	2 (6.66%)	28 (93.33%)	30 (100%)
4	Vessel Injury	0 (0 %)	30 (100%)	30 (100%)

Five (16.66%) patients had comorbidities- 2 (6.66%) had diabetes, another 2 (6.66%) had hypertension and 1 gave history of addiction. No vessel injury was reported in any case.

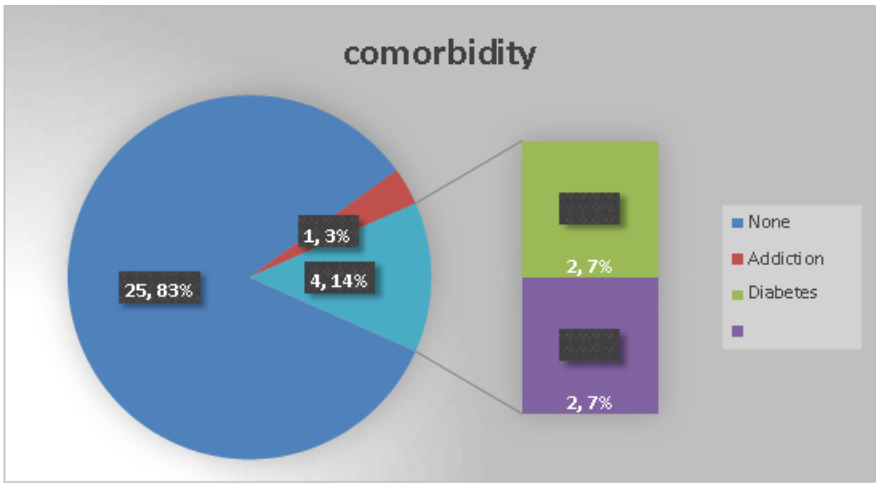
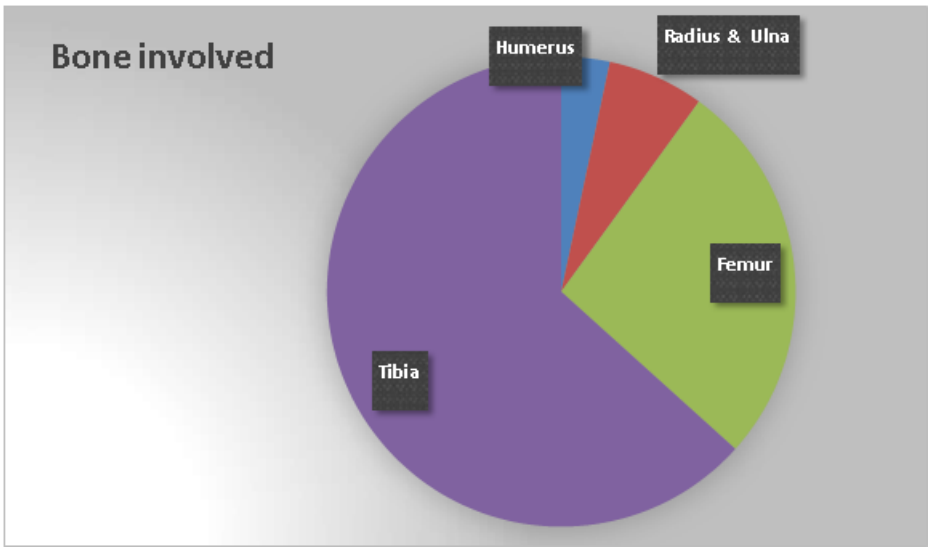


Figure 5:

Table 7: Distribution of Cases according to Bone involved.

Sr. No.	Bone involved	Number of Cases(N)	Percentage(%)
1	Humerus	1	3.33 %
2	Radius& Ulna	2	6.66 %
3	Femur	8	26.66 %
4	Tibia	19	63.33 %
Total		30	100 %



Most commonly involved bone was Tibia (63.33%), followed by femur (27%), Radius and ulna (7%) and humerus (3%).

Table 8: Distribution of Cases according to Side involved.

Sr. No.	Side involved	Number of Cases (N)	Percentage (%)
1	Right	22	73.33 %
2	Left	7	23.33 %
3	Bilateral	1	3.33 %
Total		30	100 %

In majority (73.33%) of the patients, right side was involved.

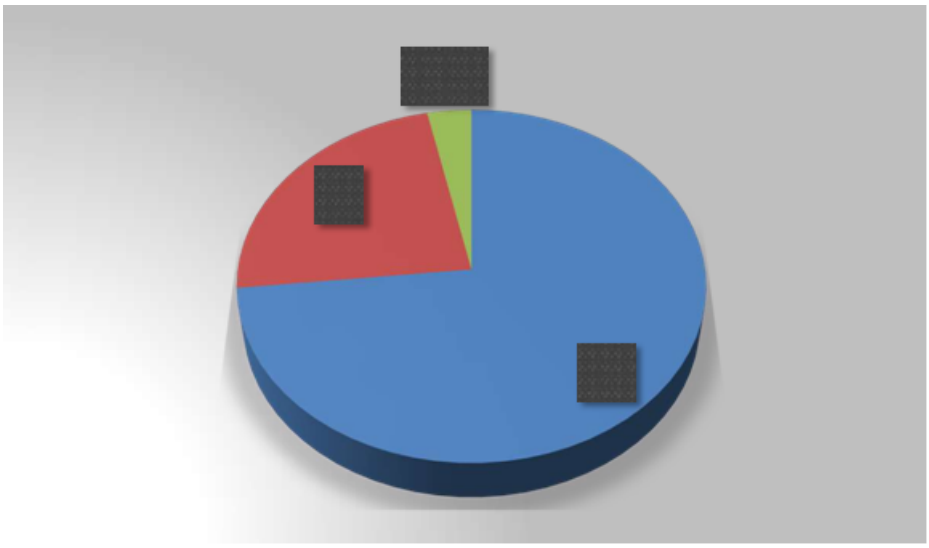


Figure 6:

Table 9: Distribution of Cases according to Mode of Injury

Sr. No.	Mode of Injury	Number of Cases (N)	Percentage (%)
1	Accidental Fall	2	6.66 %
2	Road traffic Accident	28	93.33 %
Total		30	100 %

Road traffic Accident was the mode of injury in majority (93.33%) of the patients. A (16.66%) and III B (6.66%).

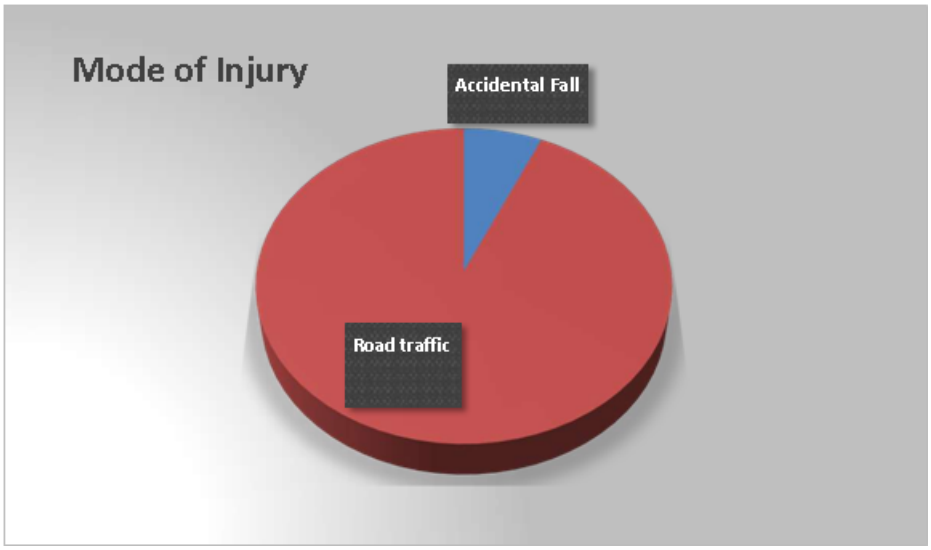


Figure 7:

Table 10: Distribution of Cases according to Gustilo andAnderson open fracture Classification

Sr. No.	Grade	Number of Cases (N)	Percentage (%)
1	Grade II	23	76.66 %
2	Grade III A	5	16.66 %
3	Grade III B	2	6.66 %
Total		30	100 %

According to Gustilo and Anderson open fracture Classification, majority of the fracturesbelonged to grade II (76.66%), followed by III A (16.66%) and III B (6.66%).

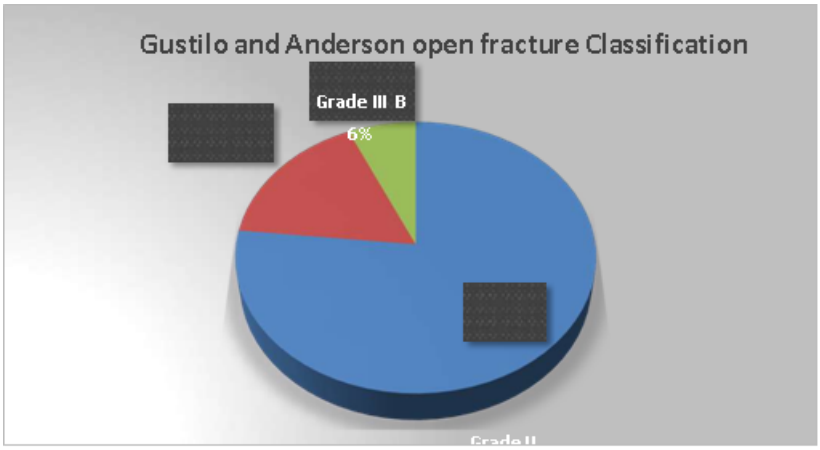


Figure 8:

Table 11: Distribution of Cases according to Implant Used

Sr. No.	Implant Used	Number of Cases (N)	Percentage (%)
1	Interlocking Nail (ILN)	27	90.00%
2	IM nail plus Dynamiccompression Plate (DCP) –MIPPO	1 (Nail + plate)	3.33 %
3	TENS	2	6.66%

In majority of the cases, Interlocking Nail was used, TENS was done in 2 cases (Of Radius- Ulna) and in one case a combination of interlocking nail and a dynamic compression plate in the form of MIPPO.

Table 12: Distribution of Cases according to Time lapse between hospital admission and Surgery

Sr. No.	Time for Surgery (Hours)	Number of Case (N)	Percentage (%)
1	4 to 8	7	3.33 %
2	8 to 12	23	76.66 %
Total		30	100 %

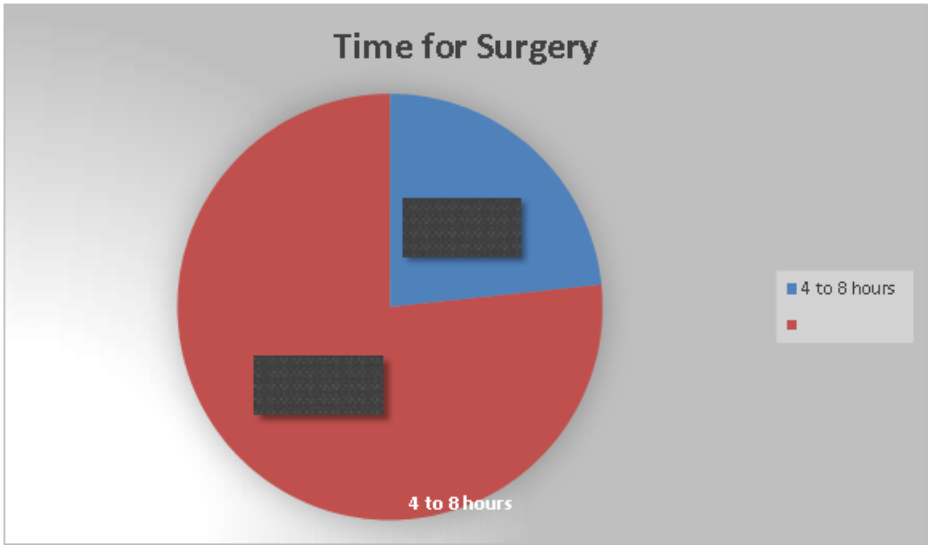


Figure 9:

Majority (76.66%) of the cases- Gustilo-Anderson grade II, were posted for emergency OT between 8-12 hours and some cases- Gustilo Grade IIIA and IIIB were posted with 4-8 hrs of hospital admission.

Table 13: Distribution of Cases according to Complications

Sr. No.	Complications	Present N (%)	Absent N (%)	Total N (%)
1	Non-Union/DelayedUnion	2 (6.66%)	28 (93.33%)	30 (100.0%)
2	Wound Infection	5 (16.66%)	25 (83.33%)	30 (100.0%)
3	Nerve palsy	0 (0 %)	30 (100.0%)	30 (100.0%)
4	Deep Vein thrombosis	0 (0 %)	30 (100.0%)	30 (100.0%)
5	Skin Complications	5 (16.66%)	25 (83.33%)	30 (100.0%)

Non-Union/Delayed Union was seen among 2 (6.66%) cases. Would infections and skin infections were seen in 5 (16.66%) cases each. None of them had nerve palsy or DVT.

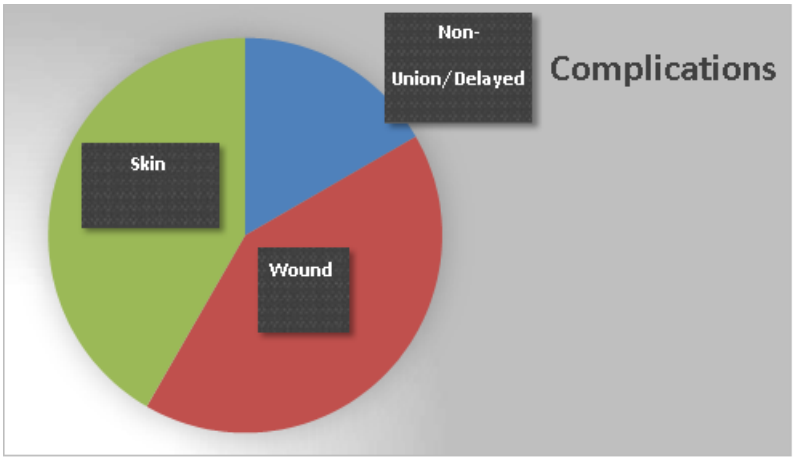


Figure 10:

Table 14: Distribution of Cases according to Blood transfusion Unit

Sr. No.	Blood transfusion	Number of Cases (N)	Percentage (%)
1	1 Unit	26	86.66 %
2	2 Unit	4	13.33 %
Total		30	100 %

26 (86.66%) patients received 1 unit of blood transfusion.

Table 15: Distribution of complications in patients based on Gustillo- Anderson type fracture classification.

Sr. No.	Grade	Delayed union	Non-Union	Infection	Skincomplications
1	Grade II	0	0	0	0
2	Grade III A	1	0	3	3
3	Grade III B	0	1	2	2

Complication were seen in Gustillo- Anderson type fracture IIIA and B. One case of delayed union occurred in IIIA type, non-union in type IIIB. Three cases each of infection and skin complications occurred in IIIA type and two cases each in IIIB type.

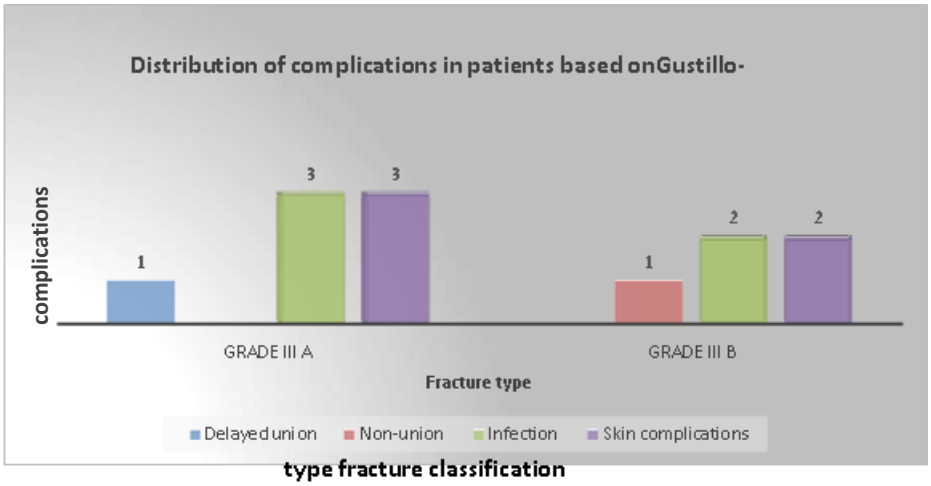


Figure 11:

Table 16: Distribution of re-operation / re-debridement in patients based on Gustillo-Anderso

Sr. No.	Grade	Cases needing Debridement	Cases needing re- debridement/ re-operation
1	Grade II	0	0
2	Grade III A	5	5 (3 times for each case)
3	Grade III B	2	2 (6 times for eachcase)

All cases in Gustillo- Anderson type fracture IIIA and B underwent debridement and re-operation.

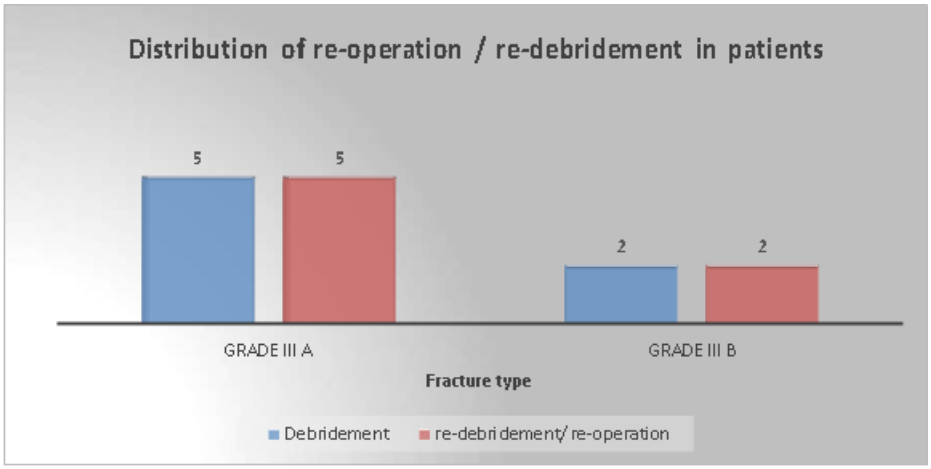


Figure 12:

Table 17: Average time for bone union in weeks in fractures based on Gustillo-Anderson typefracture classification.

Sr. No.	Grade	8-10 weeks	10-12 Weeks	12-16 weeks	>16weeks	No union
1	Grade II	20	3	0	0	0
2	Grade III A	0	0	4	1	0
3	Grade III B	0	0	1	0	1

Average time for bony union was longer in patients with group IIIA and IIIB. Average time for bone union was 8-12 weeks in patients belonging to grade II. Delayed union was seen in one patient belonging to group IIIA and non-union in one patient belonging to group IIIB.

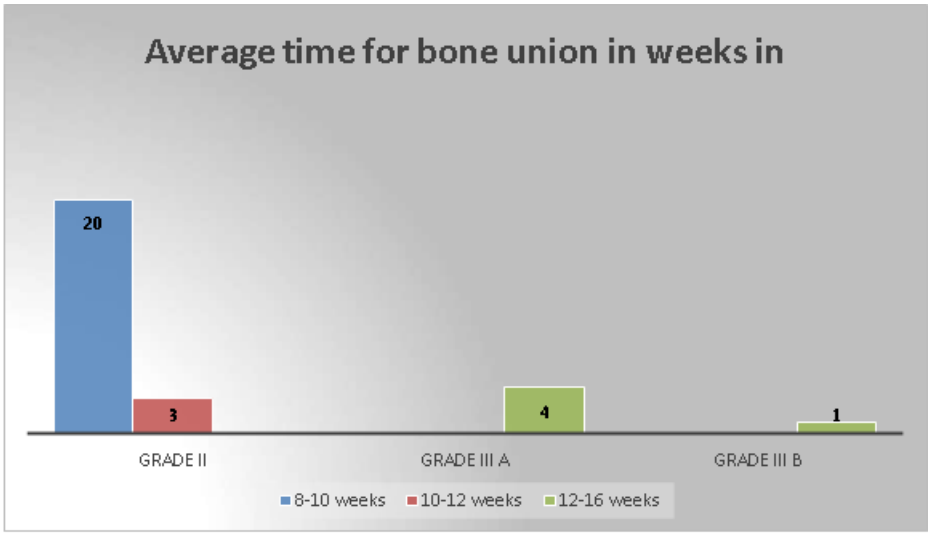


Figure 13:

Table 18: Range of movement (ROM) at adjacent joints

Range of movement at adjacent joints	Number	Percent
95-100% full range	20	66.66%
60-95%	4	13.33%
<60%	5	16.66%
Fully restricted	1	3.33%
Total	30	100.0%

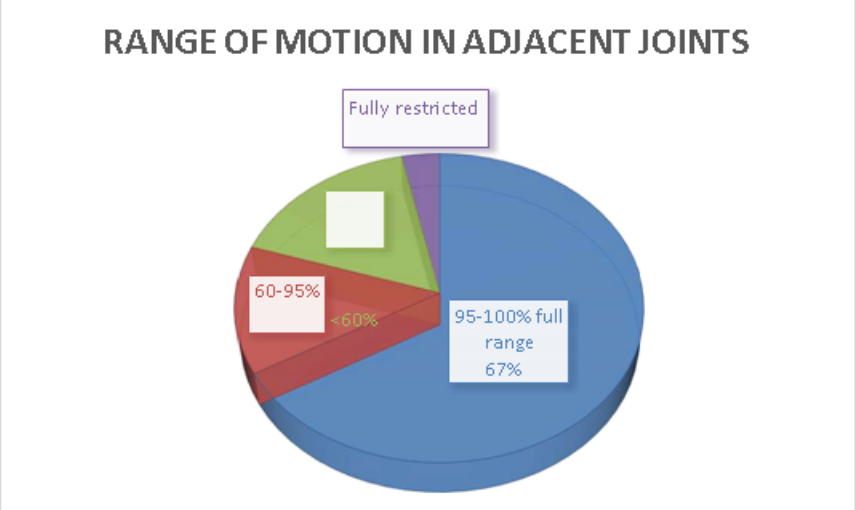


Figure 14:

Table 19: Case distribution according to End Results/ Outcomes

Result	Number of cases	Percent
Excellent	20	66.66%
Good	4	13.33%
Fair	5	16.66%
Poor	1	3.33%
Total	30	100.0%

Result was considered excellent in patients with full rom, and with no evidence of any complications.Result was considered good in patients with near to full rom, with no complications Result was considered fair in patients with restricted rom, with complications like infection and delayed union Result was considered poor in patients with non-union.

Figure 15:

Discussion

Treating open fractures of long bones can be challenging due to complications like non- union, infection and malunion.[43] Improvement in surgical techniques for fixation, soft tissue cover, and wound healing have reduced complications. Previous studies have reported that, internal fixation is superior to external fixation for open fractures.[44] This prospective study was conducted on 30 patients with open fractures of long bones Grade2,3A, and 3B.

In present study, majority of the patients belonged to age group 31-40 years (30%), followed by 51-60 years (23.33%), 19-30 years (20%), and 41 to 50 years (13.33%). Majority of the patients were males (73.33%), as India is a country with more population belonging to younger and working adult age groups most of which are males the incidence of open fractures is more in these age groups. Similar to our study, Shah RK et al,[43] in their study on IMN in 36 open fractures of tibia, reported that majority were males (68%). Ikem et al,[45] in a study on open fractures of lower limb in Nigeria also reported greater vulnerability of males to trauma. Deepak MK et al, [46] in a study on 30 patients of diaphyseal fracture femur reported mean age as 27.4 years with majority belonging to 18 and 25 years. They also reported that 80% patients were males. Kenganal et al, [47] in a study on 30 cases of metaphyseal and diaphyseal fractures of tibia, also reported that mean age was 40.1 years (Range 20-30 years) and 80% patients were males. Rajagopal H. P et al, [48] in their study on 20 patients with humerus shaft fractures reported mean age of 36 years (range 20–74) and 65% were males. Telang V et al,[49] in their study on 42 patients with fractures of distal tibia reported age ranging from 18-59 years of age with 78.57% males.

Therefore, age group 20-40 years and male sex are more predisposed to long bone fractures. Road traffic Accident (RTA) was the mode of injury in majority (93.33%) of the patients followed by accidental fall (6.66%). RTA is one of the commonest causes of morbidity and mortality seen in orthopedic department.[45] In present study, majority (73.33%) of the patients,right side was involved. Most commonly involved long bone was tibia (63.33%), followed by femur (27%), Radius and ulna (7%) and humerus (3%). Similar to our study, Deepak MK et al,[46] reported that 60% fractures were on the right side, RTA (83.34%) was the commonest mode of injury followed by accidental fall from height (13.33%). Kenganal et al, [47] reported RTA was mode of injury in 80% cases followed by fall (16.67%) and assault in one case. In a study by Ikem et al, [45] also RTA was the cause in majority (71%) patients. Rajagopal H. P et al, 48 reported that right humerus was involved in 55.0% cases and left in 45.0%. RTA (75%) was the commonest mode of injury followed by, fall on outstretched arm (20%), fall from height (5%). Telang V et al, [49] reported commonest mode of injury as RTA (52.39%), followed by fall from height (16.67%), patients at home (11.9%), assault (4.76%) and sport related injury (14.28%). Therefore, it is a corollary that majority patients were males, belonged to 19-40 years age, and majority open fractures occurred in tibia and femur. Quamar Azan et al,[50] reported most commonly involved bone was tibia (47.14%), followed by forearm bones (21.42%), femur (18.57%) and humerus (11.42%). Mode of injury was RTA (55.55%), industrial accidents (12.69%), fall from height (11.11%), gunshot injuries (7.93%), and crush injuries (6.34%).

According to Gustilo and Anderson open fracture Classification, majority of the fractures belonged to grade II (76.66%), followed by III A (16.66%) and III B (6.66%). In the study by Shah RK et al, [43] 13 (36.11%) fractures belonged to grade I, 14

(38.88%) belonged to grade II, 5 (13.88%) belonged to grade IIIA and 4 (11.11%) belonged to grade IIIB. Kenganal et al,[47] reported that 60% patients belonged to type I and the rest belonged to type II. Quamar Azan et al,[50] in their study on internal fixation in reported that 63 patients, reported 70 compound fractures of which, 46 belonged to Type IIIA and 24 belonged to type IIIB. Aslan et al,[51] reported 9 (47.36%) belonged to type IIIA, 7 (36.84%) belonged to III B and another 3 (15.87%) belonged to group IIIC.

In this study, interlocking Nail was used in all 90% of the cases. In Two cases TENS was done. In one case, a combination of intramedullary interlocking nail was used with a dynamiccompression plate. In majority (76.66%) of the cases, time for surgery was between 8-12 hours. Kenganal et al, [47] reported using ILN in all cases. Rajagopal H. P et al, [48] used antegrade interlocking nail in all cases and mean duration of surgery was 52.3 minutes (range 40–74).

Non-Union/Delayed Union was seen among 2 (6.66%) cases. Would infections and skin infections were seen in 5 (16.66%) cases each. Delayed union and malunion occurred in patients of older age group (> 51 years). Infections and skin complications were present in patients of all age groups. None of them had nerve palsy or DVT. One case of non-union which occurred, the patient was an alcohol addict and the one case of delayed union, patient was diabetic. Two cases of infection and skin complications were also seen in diabetic patients. Complications were seen in Gustillo- Anderson type fracture IIIA and B. Average time for bony union was longer in patients with group IIIA and IIIB. Average time for bone union was 8-12 weeks in patients belonging to grade II. Delayed union was seen in one patient belonging to group IIIA and non-union in one patient belonging to group IIIB. All cases in Gustillo-Anderson type fracture IIIA and B underwent debridement and re-operation.

26 (86.66%) patients received one unit of blood transfusion. The overall rate of union is better than past studies with external fixation.52, 53Similarly, Shah RK et al, [43] reported four delayed unions and one non-union. They were eventually treated with good results with bone grafting.Two cases of superficial infections (grade II) and one case of deep infection were reported. No complications requiring implant removal or amputation were required. Mean time for bony unions are 22 weeks. They also reported that, time for union was greater in patients with type III B. Deepak MK et al,[46] reported delayed union in two cases (6.6%), shortening of the limbin four cases (13.33%), superficial infection in 5 cases and one case of refracture with broken nail in situ, where exchange nailing was done. Mean time of bony union was reported as 16.5 weeks. Rajagopal H. P et al, [48] reported that all were closed injuries, with no radial nerve palsy. One case of superficial wound infection was seen. Mean time for union was 90 days (range 84–120).

In majority (80%) of the patients, the duration of hospital stay was between 1-2 weeks. Four (13.33%) patients stayed beyond 2 weeks. In Our study result was considered excellent in patients with full rom, and with no evidence of any complications, result was considered good in patients with near to full rom and with no complications, result was considered fair inpatients with restricted rom, with complications like infection and delayed union and Result was considered poor in patients with non-union and 66.66% patients had excellent results,

13.33% patients achieved good results, 16.66 % fair results and in 3.33% patients, the results were poor. Kenganal et al, [47] reported 43.33% patients had excellent results, 33.33% patients achieved good results, 16.67 % fair results and in 6.67% patients, the results were poor. Aslan et al,[51] in 19 patients with open tibial fractures with definite treatment reported excellent functional outcome in 31.57% patients, good in 42.10% patients, fair in 10.53% and poor in 15.78%. Rajagopal H. P et al, [48] used Constant–Murley shoulder score to assess functional outcome and reported excellent score in 70%, followed by good in 25%, and fair in 5%. The mean duration of hospital stay was 5 days (range 03–12). Quamar Azan et al, [50] used Katenjian criteria for assessing functional outcome and reported 62.85% good to excellent results.

Therefore, primary definitive fixation of open long bone fractures Gustilo-Anderson grade II, IIIA and B have favorable outcomes. It provides successful union and good functional outcome, especially in Gustilo-Anderson grade II and IIIA, grade IIIB fractures also only with extensive debridement and proper antibiotic treatment and prophylaxis.

Conclusion

From our prospective study conducted on 30 cases we can conclude that primary definitive internal fixation in open fractures Gustilo-Anderson grade II, IIIA and IIIB of long bones (femur, tibia, humerus, radius-ulna) provides favourable functional outcome.

The functional outcome ranges from excellent too good in cases of Gustilo-Anderson Grade II, but in Grade IIIA and IIIB it ranges from fair to poor. As the grade of open fracture increases the measures to be taken to avoid complications also increase. But with proper initial surgical debridement and wound care and with proper antibiotic prophylaxis and re-debridements if necessary, a favourable outcome can also be achieved in higher grades of Gustilo-Anderson.

Therefore, we can conclude that primary definitive fixation of open long bone fractures Gustilo-Anderson grade II, IIIA and B have favorable outcomes. It provides successful union and good functional outcome, especially in Gustilo-Anderson grade II and IIIA, grade IIIB fractures also only with extensive debridement and proper antibiotic treatment and prophylaxis.

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