Early and late intramedullary nailing of femur fracture: A single center experience

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ABSTRACT

Background: Femur fracture (FF) is a common injury, and intramedullary nailing (IMN) is the standard surgical fixation. However, the time of intervention remains controversial. We aimed to describe the reamed IMN (rIMN) timing and hospital outcomes in trauma patients presenting with FF.

Materials and Methods: A retrospective analysis was conducted for all patients admitted with FF and they underwent fixation at level 1 trauma unit between January 2010 and January 2012. Patients were divided into Group I with early rIMN (<12 h) and Group II with late rIMN (≥12 h). Patients’ demographics, clinical presentations, mechanism of injury, pulmonary complications, organ failure, length of stay, and mortality were described.

Results: A total of 307 eligible patients with FF were identified (156 patients in Group I and 151 patients in Group II). Patients in Group II were older (36 ± 18 vs. 29 ± 9; \( P = 0.001 \)) and had higher rate of polytrauma (35% vs. 18%, \( P = 0.001 \)), head injury (5% vs. 12%, \( P = 0.68 \)) and bilateral FF (10.7% vs. 5.1%; \( P = 0.07 \)) in comparison to Group I. Group II had longer stay in Intensive Care Unit (7 [1–56] vs. 2 [1–17] days; \( P = 0.009 \)) and hospital (13 [2–236] vs. 9 [1–367]; \( P = 0.001 \)). There were no significant differences in outcomes between the two groups in terms of sepsis, renal failure, fat embolism, adult respiratory distress syndrome and death.

Conclusions: Based on this analysis, we believe that early rIMN is safe in appropriately selected cases. In patients with traumatic FFs, early rIMN is associated with low hospital complications and shorter hospital stay. The rate of pulmonary complications is almost the same in the early and late group. Further prospective randomized studies with large sample size would be ideal using the information garnered from the present study.

Key Words: Femur, fracture, intramedullary nailing, outcomes, reamed, timing, trauma

INTRODUCTION

Traumatic femur fractures (FFs) continue to be a major cause of morbidity and mortality worldwide. \(^1\) Regardless of the patient age and injury severity, a previous study showed that in comparison to delayed stabilization, an early definitive stabilization of FF is found to have fewer complications. \(^2\) Currently the standard of care for definitive treatment for most diaphyseal fractures of the femur is intramedullary nailing (IMN). \(^3\) This approach can be performed expediently, through minimal incisions with almost no significant blood loss, and in most cases, patients can be early mobilized. However, in patient with multiple injuries, the type and timing of FF stabilization remains controversial. \(^4\) There are rationales for early

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FF fixation as it associated with increased patient mobility, lesser pulmonary complications, and reduced length of hospital and Intensive Care Unit (ICU) stay.\textsuperscript{[5-8]} Some studies suggested that early definitive surgery in polytrauma patients, especially with chest and head injuries, resulted in increased rate of complications and mortality.\textsuperscript{[9-16]} Contrarily, Brundage \textit{et al.}\textsuperscript{[17]} reported early internal fixation after adequate resuscitation (<24 h) was correlated with better prognosis in concomitant head or chest trauma patients. However, regardless of the associated injuries, two systematic reviews demonstrated no difference in morbidity or mortality between early (<24 h) and late operative treatment of femoral shaft fractures.\textsuperscript{[18,19]}

Alternatively, damage-control orthopedics (DCO) involves external fixation followed by delayed definitive treatment has the advantage of giving more time for resuscitation, and might halt the inflammatory cascade provoked by polytrauma and definitive surgery.\textsuperscript{[20-22]} The present study aims to describe the reamed (rIMN) and its timing on the in-hospital outcomes in trauma patients presenting with FF.

**MATERIALS AND METHODS**

A retrospective analysis was conducted for data of the trauma registry at Hamad General Hospital, the only level 1 trauma center in Qatar over a period of 24 months from January 2010 to January 2012.

**Inclusion criteria**

All patients ≥14 years and <80 years who sustained trauma with single or bilateral FFs (shaft) and underwent IMN (piriformis entry and close nailing). All patients underwent reamed antegrade nailing. Although retrograde nailing is preferable in bilateral FF, our institution used that for some ipsilateral femur and tibia fracture as well as some distal shaft FF; this mostly depends on the surgeon discretion and availability of resources. Using AO nails or Trigen nails entirely depends on surgeon’s preference.

**Exclusion criteria**

Patients <14 and ≥80 years, patients who died within 24 h of admission, and patients with femoral neck fractures, or pathological fracture.

All the trauma patients were initially resuscitated in the trauma room according to advanced trauma life support protocol. Patients were taken to the operating room (OR), trauma ICU, or trauma ward depending on the patient stability and associated injuries. The charts of all patients were reviewed and data were gathered including age, sex, mechanism of injury, pattern of injuries (unilateral or bilateral), FFs, associated injuries to other systems, injury severity scoring (ISS), abbreviated injury scale, systemic inflammatory response syndrome (SIRS) and hospital outcomes (length of stay [LOS], pulmonary complications, organ failure, sepsis, and mortality).

**Treatment groups**

Patients were divided into two groups: Group I (early); those whose FFs were treated with primary rIMN <12 h of injury and Group II (late); those whose FFs were treated ≥12 h. All operative notes were reviewed to determine the time and date of each surgical procedure.

**Definitions**

SIRS was defined as presence of the following criteria: Body temperature ≥38°C/≤36°C, heart rate ≥90 bpm, respiratory rate ≥20/min or PaCO\textsubscript{2} <32 mmHg, and neutrophil count ≥12,000/mL or ≤4000/mL.\textsuperscript{[23]}

Adult respiratory distress syndrome (ARDS) is defined as the acute onset of respiratory failure, bilateral infiltrates on chest radiograph, hypoxemia as defined by a PaO\textsubscript{2}/FiO\textsubscript{2} ratio ≤200 mmHg, and no evidence of left atrial hypertension or a pulmonary capillary pressure <18 mmHg (if measured) to rule out cardiogenic edema.\textsuperscript{[24]}

Polytrauma is defined as two or more severe injuries in at least two areas of the body with an ISS ≥16.\textsuperscript{[25]}

Death during the primary hospitalization was documented in the trauma database.

The need for informed consent was waived by the Ethical Committee since rights and interests of the patients would not be violated and their privacy and anonymity would be assured by this study design. This study was approved by the Medical Research Center at Hamad Medical Corporation; Institutional Review Board#12176/12.

**Statistical analysis**

The data were presented as proportions, medians, or mean ± standard deviation, as appropriate. Comparison was carried mainly between early (<12 h) and late treatment (≥12 h) groups. Differences in categorical variables were analyzed using the Chi-square test and the continuous variables were analyzed using Student’s t-test. Two-tailed \( P < 0.05 \) was considered statistically significant. All data analyses were carried out using the Statistical Package for the Social Sciences version 18 (SPSS, Inc., Chicago, IL, USA).

**RESULTS**

During the study period, out of 2800 trauma patients admitted to our center, 355 patients had FFs. After
exclusion of 48 patients who were not fixed due to early mortality from severe head injury, 307 patients met the inclusion criteria. The majority of patients were males (96%) involved in traffic-related injuries or fall from height during construction work. Patients’ age ranged from 16 to 48 years with a mean of 33 ± 14.7 years. The patient demographics in each group were similar for sex and mechanism of injury; however, patients in Group II were 7 years older (P = 0.001). Open fractures were greater in Group I in comparison to Group II (14% vs. 4%; P = 0.002).

There were 24 (8%) patients with bilateral FFs, 28 (9%) patients with open fractures and 38 (12.4%) patients had associated tibia fractures.

Patients were divided into two groups: 156 (51%) were in Group I (rIMN < 12 h) and 151 (49%) were in Group II (rIMN ≥ 12 h). There were 22 (14%) and 6 (4%) patients with open FF in Group I and Group II, respectively, (P = 0.002). In Group I, bilateral FF was present in eight (5%) cases whereas 16 (10.7%) patients had bilateral FFs in Group II. The associated tibial fractures were comparable among the two groups [Table 1].

The median time from admission to primary IMN for the early group was 3.2 h and for the late group was 68 h. Severe injury (ISS > 15) was more frequently seen in Group II in comparison to Group I (23 ± 6 vs. 21 ± 4; P = 0.044). There were significantly more number of patients in Group II who had polytrauma than in Group I (34% vs. 17%; P = 0.001) [Table 2].

The number of mean red blood cells units transfused within first 24 h was comparable among the two groups [Table 3]. Group II had longer stay in ICU (7 ± 1–56) vs. 2 ± 1–17; P = 0.009) days and hospital (13 ± 2–236) vs. 9 ± 3–367; P = 0.001). Although, complications were greater in Group II, there were no significant differences in the outcomes between the two groups in terms of wound infection, sepsis and ARDS. The rates of SIRS and fat embolism were similar in the two groups and no cases of renal failure were reported in either group. Only one case of death was reported in Group I; it was isolated FF complicated with fat embolism and ARDS.

**DISCUSSION**

The present study describes the rIMN timing (early vs. late fixation) and hospital outcomes in nonhomogenous trauma patients presenting with FF in a single trauma tertiary center. According to this analysis, the rate FF is around 11 cases/100,000/year which is consistent with the international rates (10–21 cases/100,000/year). Nearly, half of our patients had early fixation and showed few complications, and short hospital stay. This finding is in agreement with previous studies showing a potential benefit of early definitive surgery in patients who are stable enough for IMN.\(^7\)\(^8\) Moreover, the late FF fixation group tended to be severely injured, as evident from ISS and associated injuries. In addition, the most common cause of delay in polytrauma patients was head injury and lack of immediate OR availability.

The present report also shows that the hospital complications in patients who underwent rIMN beyond 12 h of admission were not high as well. In a recent study by Harvin et al.,\(^1\) a 57% decrease in pulmonary complication was observed when IMN was performed within 24 h of admission and even when considering only those patients with high ISS.

The only statistical significant difference in our data is the length of ICU and hospital stay, which basically reflected the higher ISS and thus the severity and multiplicity of

### Table 1: Demographics and outcomes based on time to operate

| Variable                  | <12 h (n=156) (%) | ≥12 h (n=151) (%) | P  |
|---------------------------|------------------|------------------|----|
| Age (mean±SD)             | 29 ± 9           | 36 ± 18          | 0.001|
| Males                     | 149 (95.5)       | 137 (88.7)       | 0.27 |
| Motor vehicle crash       | 74 (47.4)        | 71 (47)          | 0.45 |
| Pedestrian injury         | 14 (9)           | 14 (9.3)         | 0.45 |
| Fall from height          | 36 (23)          | 46 (30.5)        | 0.45 |
| Bilateral                 | 8 (5.1)          | 16 (10.7)        | 0.07 |
| Open fracture             | 22 (14)          | 6 (4)            | 0.002|
| Tibia fracture            | 18 (11.7)        | 20 (13.7)        | 0.60 |
| ISS >15 (polytrauma)      | 22 (17-34)       | 23 (17-43)       | 0.044|
| Mean (SD)                 | 21 ± 4           | 23 ± 6           | 0.001|
| Time (h) median; range    | 3.2 (1-12)       | 68 (13-526)      | 0.001|

### Table 2: Associated injuries

| Variable                  | <12 h (n=156) (%) | ≥12 h (n=151) (%) | P  |
|---------------------------|------------------|------------------|----|
| Polytrauma (%)            | 27 (17)          | 51 (34)          | 0.001|
| Head AIS                  | 3 (2-3)          | 3 (2-5)          | 0.68 |
| Chest AIS                 | 3 (1-3)          | 3 (1-3)          | 0.79 |
| Abdominal AIS             | 2 (2-4)          | 2 (2-4)          | 0.13 |
| Pelvis AIS                | 2 (2-4)          | 2 (2-4)          | 0.44 |

### Table 3: Posttreatment complications

| Variable                  | <12 h (n=156) (%) | ≥12 h (n=151) (%) | P  |
|---------------------------|------------------|------------------|----|
| ICU LOS                   | 2 (1-17)         | 7 (1-56)         | 0.009|
| Hospital LOS              | 9 (1-369)        | 13 (2-236)       | 0.001|
| RBCs units (1st 24 h)     | 5.9 ± 8.6        | 8.1 ± 5.4        | 0.430|
| SBP < 90 mmHg             | 4 (2.5)          | 5 (3.3)          | 0.67 |
| SIRS                      | 54 ± 54.1        | 54.1             | 0.99 |
| Bed sore                  | 0 (0)            | 1 (0.7)          | 0.39 |
| Wound infection           | 3 (1.9)          | 8 (5.3)          | 0.11 |
| Sepsis                    | 1 (0.6)          | 2 (1.3)          | 0.54 |
| Renal failure             | 0 (0)            | 0 (0)            | 1.00 |
| Fat embolism              | 1 (0.6)          | 1 (0.7)          | 0.54 |
| ARDS                      | 1 (0.6)          | 2 (1.3)          | 0.032|
| Deaths                    | 1 (0.6)          | 0 (0)            | 0.32 |

SD: Standard deviation, ISS: Injury severity scoring

AIS: Abbreviated injury scale, All continuous data are presented in median and range

ICU: Intensive Care Unit, RBCs: Red blood cells, SBP: Systolic blood pressure, ARDS: Adult respiratory distress syndrome, LOS: Length of stay, SIRS: Systemic inflammatory response syndrome
associated injuries, particularly head injury which may confound the decision to operate and prolong the stay both in ICU and hospital.

Consistently, Brundage et al.,[17] did find a significant increase in complications such as pneumonia, ARDS, and length of hospital stay among patients who were managed between 2 and 5 days after the injury. However, the authors did not report significant difference in mortality in association with the treatment timing. Another retrospective study evaluated 97 severely injured patients with ISS > 25 and found no difference in the rate of ARDS, multiple organ failure, and LOS when early IMN and DCO were compared.[28] In our study, only two cases underwent external fixation before conversion to rIMN in Group II.

A recent multicenter randomized control trial compared early IMN (<24 h) and DCO for FFs in 165 patients.[27] The authors concluded that primary femoral IMN is associated with shorter ventilation time in stable cases, a higher incidence of lung dysfunction in borderline cases in comparison to those who underwent external fixation and later conversion to IMN. In that study, IMN affected the outcome mainly in patients with polytrauma.

Also, Nahm et al.[2] reported that early fixation is associated with fewer complications (pulmonary problems, organ failure, sepsis, and deep vein thrombosis [DVT]), and shorter LOS suggesting that it is an appropriate option for most patients. In addition, delay in definitive stabilization of FFs was directly proportional to the development of both pulmonary and other complications. These findings are coined in other studies.[12,16] Morshed et al.[16] studied the impact of timing of definitive femoral shaft fracture fixation among polytrauma subjects with ISS > 15. Patients were divided into three subgroups based on the timing of femoral fixation (within 12 h, 12 h to 24 h, and > 24 h). Mortality rates for these groups were 3.7%, 1.9%, and 4.3%, respectively. In our study, the overall mortality was very low, one death only in the early group (<12 h) that was related to fat embolism and pulmonary complications.

It has been proposed that delayed femoral repair beyond 12 h after injury may afford time for adequate resuscitation, which could reduce the risk of mortality by 50% in polytrauma patients and head injury.[16]

The incidence of ARDS was nonsignificantly lower in the early group, compared to the delayed group in our study. Nahm et al.[2] reported ARDS more often in patients treated after 24 h (4.8%). Harvin et al.[4] reported very low rate of ARDS (0.6%) for those who underwent IMN, even in the presence of multiple injuries. Furthermore, O’Toole et al.[28] studied the ARDS incidence in several subgroups of patients with polytrauma who had early definite fixation versus DCO and found that patients who underwent primary IMN had lower incidence of ARDS (1.5%).

The proportion of sepsis in the present study was higher in the delayed treatment group, however, this observational difference was statistically nonsignificant and could be attributed in part to the presence of associated injuries and/or prolonged hospital LOS.

Because the complications were low in early treatment group, early fixation could facilitate early mobility, minimize hospital stay and reduce the risk of sepsis. We could not report pneumonia or DVT during patients hospital stay.

The low rate of bilateral FF (0.8%) in our study over 2 years is consistent with the current literature.[28]

**Limitations**

There are some limitations to this study. It is a retrospective observational study and so the major bias is that the groups were retrospectively assigned based on the intervention (i.e. early or late fixation) which may introduce a selection bias. The younger, healthier and less injured cases got early fixation and vice versa. Therefore, patients with lower injury severity were likely elected to proceed with earlier intervention than the older, more severely injured patients. So, the two groups (early vs. late fixation) were not homogenous and cannot be controlled well. Unmeasured confounding factors such as time from injury to hospital admission could bias the effect of treatment time. In addition, head injury was the most common cause for the delayed intervention in our study population. Given the small sample size, and numbers of outcome variables, multivariate analysis could not be performed to adjust confounders in the study. The surgical procedures duration was not documented in the database. This study addressed only the short-term outcome, i.e. the pulmonary complication and hospital stay and therefore no long-term follow-up was reported, which is another limitation of this analysis. Although, Gustilo–Anderson open fracture classification system is the widely used classification system for open fractures,[28] we used broadly the term “open fracture” to refer to all fractures that had communication to the exterior and so we did not segregate them in groups.

The power of the study is not adequate to draw solid comparative difference between the two groups and to analyze those who underwent surgery beyond 12 h. Moreover, selection bias cannot be ruled out as the decision for surgery type was physician discretion. However, with the abovementioned limitations, the beneficial effect of early fixation cannot be ignored.
CONCLUSIONS

We believe that early fixation is safe in appropriately selected cases. In our center, patients presenting with traumatic FFs, early rIMN is associated with low hospital complications and shorter hospital stay. The rate of pulmonary complications is almost the same in the early and late group. Further prospective randomized studies with large sample size would be ideal using the information garnered from the present study.

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Conflicts of interest
There are no conflicts of interest.

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