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Original Article

Histopathological examination of bone debris from reaming of interlocking intra-medullary nail fixation of long bone fractures with concomitant head injury

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ABSTRACT

Background/Aim: The aim of study was to test, for the presence of osteoblasts in the reaming debris of intramedullary nailing of femoral and tibial fracture in patients with and without severe head injury.

Methods: Two groups of patients were studied. Group A (n = 32) had long bone fractures in addition to having head injuries. Group B (n = 35) had only long bone fractures. The fractures in the 2 groups of patients was treated by inter medullary nailing. Osteoblasts in the debris of the inter medullary nailing was compared between the 2 groups of patients. **Results:** The results demonstrated that histopathological specimens from reaming debris of fractured femur and tibia in patients with head injury showed osteoblasts in (82.9%) and in (27.5%) of patients with isolated long bone fractures (p < 0.001).

Conclusion: Healing indicators in diaphyseal fractures and concomitant head injury confirm fast and adequate healing in these patients and the presence of plenty of osteoblasts in their reaming debris may reflect a proof of accelerated fracture healing environment.

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1. Introduction

There is clinical evidence to suggest that fractures heal more rapidly in patients with head injuries. The mechanism underlying this orthopaedic phenomenon is not well understood. The regulation of bone healing after long bone fractures is subtle and involves many pathological processes. Early clinical reports in researching the correlation between

accelerated bone healing and nervous tissue damage in head injuries were inconclusive and demonstrated no evidence of accelerated union or increased callus formation and still, there is a debate, whether this rapidly forming new bone is fracture callus or a variant of heterotopic ossification, a common complication of traumatic brain injury.^{1–16}

Other authors in the literature believed that there is evidence to suggest that fractures heal more rapidly in patients

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with co-existing head injury and that this may be due to a factor or factors released into the blood from the head injury site acting to promote fracture repair.^{17–25}

The objective of this prospective controlled study was to test, histopathologically the presence of bone forming cells osteoblasts in the reaming debris of intra-medullary nailing of femoral and tibial diaphyseal fracture in patients with and without severe head injury to indicate or not the presence of accelerated bone healing environment at the fracture site with plenty of osteoblasts in patients with severe brain damage. The healing rate, healing time, and the amount of union callus formed in patients with femoral and tibial diaphyseal fractures and concomitant head injuries were compared with those of patients with long bone fractures only. All long bone fractures was fixed by static reamed interlocking intra-medullary nails.^{26–31}

2. Patients and methods

From 19/09/2011, we started to recruit patients in this prospective controlled study. Patients in the age group of 20–60 years, and without history of chronic ill-health or systemic diseases were included. Patients on permanent medications and therapy for diabetes mellitus, ischaemic heart diseases, chronic renal failure, endocrine diseases, and patients on corticosteroids for bronchial asthma, rheumatoid arthritis, other arthritis, and inflammatory and autoimmune diseases were excluded from the study. The recruited patients were divided into two groups: Group (A) were patients with severe head injuries admitted to the ICU with GCS of 8 or less with diaphyseal femoral or tibia fractures and Group (B) were patients with diaphyseal femoral or tibia fractures only. All the long bone fractures in the two groups of patients have been treated surgically by open or closed reduction and skeletal stabilization by static reamed interlocking intra-medullary nail. The bony debris of intra-medullary reaming of all patients was sent to histopathological examination for osteoblasts.

2.1. Statistical analysis

Results were analysed with SPSS for Windows (Version 16). Means and standard deviations were determined. Mean scores between the two groups of patients were compared using chi square and the student t-test. p value < 0.05 was considered statistically significant.

3. Results

32 patients were recruited in group (A) and 35 were recruited in group (B). All patients finished their follow-up until the primary end point of the study of long bone fractures union or nonunion. In group (A) patients, the mean age was 29.7, range (18–39) years. The patients of this group were 30 males (93.75%) and 2 females (6.25%). The accidents in which, these patients were involved were high velocity accidents, with 21 patients (65.62%) have been involved in (RTA), and the remaining 11 (34.38%) have been involved in falling from

height accidents. The mean GCS in this group of patients was 6/15, range (4–8)/15.

35 long bones were fractured in these 32 patients, 26 (74.3%) closed fractures and 9 (25.7%) open fractures. There were 18 (51.4%) fractured shafts of the femur, and 17 (48.6%) fractured shafts of the tibia. All long bone fractures in this group of patients with associated severe head injuries were fixed by static reamed interlocking intra-medullary nail.

The 35 histopathological specimens from the reaming debris of the fractured long bones of femur and tibia in this group showed plenty of osteoblasts in 29 (82.9%), 16 (89%) femur and 13 (76.5%) tibia.

The mean time to union in this group was 6.9, range (5–16) weeks. There were no cases of non-union of long bones in this group. The mean maximal thickness of union bridging callus as shown in X-rays or CT scan was 26.3, range (7–48) mm. The mean healing rate, which is defined as the maximal thickness of union bridging callus in mms as evident in X-rays or CT scan, divided by the time to healing in weeks, was 2.8, range (1.4–8.6) mm/week. (Figs. 1–4).

In group (B) patients, the mean age was 32.4, range (21–47) years. The patients of this group were 30 males (85.71%) and 5 females (14.29%) with ratio of 6:1. The accidents in which, these patients were involved were high velocity accidents, with 29 patients (82.86%) have been involved in (RTA), and the remaining 6 (17.14%) have been involved in falling from height accidents.

There were 40 fractured long bones in 35 patients in group (B), closed in 28 (70%) and open in 12 (30%). Among the 40 fractured long bones in this group, there were 22 (55%) fractured

Fig. 1 – Showing X-ray of femur with accelerated fracture healing and abundant callus formation in a patient with severe head injury and long bone fracture group (A) patient.

Fig. 2 – Showing X-ray of fracture femur with atrophic nonunion and broken nail metal failure in a patient with long bone fracture only group (B) patient.

shaft of femur and 18 (45%) fractured shaft of tibia and fibula. All long bone fractures in this group of patients have also been fixed by static reamed interlocking intra-medullary nail.

The 40 histopathological specimens from the reaming debris of the fractured long bones of femur and tibia in this group showed scarce or few osteoblasts in 11 (27.5%), 7 (31.8%) femur and 4 (22.2%) tibia.

Fig. 3 – Histopathology showing plenty of osteoblasts in the bone debris of reaming of interlocking intra-medullary nailing in group (A) patient with femoral diaphyseal fracture with associated severe head injury.

Fig. 4 – Histopathology showing no osteoblasts in the bone debris of reaming of interlocking intra-medullary nailing in group (B) patient with femoral diaphyseal fracture only.

Among the 40 fractured long bones in the 35 patients of this group, 31 fractures (77.5%) united, but 5 (16.1%) of them, although they did not show radiological signs of nonunion, completed their fractured long bones' union after delayed union of (32–41 weeks). 9 (22.5%) fractured long bones went into atrophic nonunion, which were confirmed radiologically and during secondary procedures. None of the long bone fractures with intra-medullary reaming debris showed osteoblasts ended by delayed or nonunion in the patients of this group.

The mean healing time in this group of patients was 21.6, range (12–43) weeks. The mean maximal thickness of callus in the united fractures in this group was 8.1, range (2–20) mm. The mean healing rate was 0.38, range (0.12–1.7) mm/week.

4. Discussion

Acceleration of fracture healing in severe head injury patients is still controversial. The investigations of this relation in the literature have been divided between studies and authors who denied its presence and others who proved it.^{1–16}

Garland and Toder (1980)³ stated unequivocally following a study of 47 fractures of tibias in head-injured adults that union occurred in those individuals at the same rate and frequency as it did in a population without head injuries. This observation has been subsequently corroborated by similar studies of fractures of femurs (Garland et al, 1982),⁵ elbow (Garland and O'Hollaren, 1982)² and forearm (Garland and Dowling, 1983)¹ in head-injured adults. The only abnormality of bone formation that was detected was an unusually high incidence of heterotopic ossification without an effect on clinical or radiological fracture union. Several of these studies are less applicable to current practice due to the methods of fracture treatment employed then, with frequent non-operative management and no control group of similarly treated patients for comparison.^{6–16}

Newman et al, 1987, in retrospective uncontrolled study (17) demonstrated unusually rapid healing of 13 closed fractures of long bone in patients with concomitant severe head injuries, supporting the understanding of previous authors (Apley and Solomon, 1982; and Rockwood and Green, 1984).^{21,22}

Giannoudis et al, 2006, revealed, in a study of 17 patients with head injury and associated femoral shaft fracture and 50 without head injury (25 treated with reamed and other 25 with unreamed nailing technique), a significantly shorter mean time to fracture union in patients with head injury than either the reamed or unreamed nailing groups without head injury.²⁴

Yang et al, 2012, in a retrospective study compared the healing of femoral shaft fractures in 20 patients with associated traumatic brain injury (TBI) to 54 without brain injury and confirmed that an injury to the brain may be associated with accelerated healing and enhanced callus formation in femoral shaft fractures.²⁵ They also, concluded that the severity of the injury to the brain, the type of intracranial haemorrhage and gender were not statistically significant factors in predicting the rate of bone healing and extent of final callus formation.²⁵

To the best of our knowledge, the current prospective controlled study is the first of its kind to search for cellular evidence in the reaming debris of intra-medullary nailing of femoral and tibial diaphyseal fractures for the acceleration of bone union in patients with severe head injuries and concomitant long bone fractures. The histopathological results of this study showed that osteoblasts, the bone forming cells, found in plenty and in statistically significant higher incidence in the reamed femur and tibia fractures in (82.9%) of patients with associated severe head injuries compared to their few and scarce presence and only in (27.5%) of patients with isolated long bone fractures ($p < 0.001$). Comparing the time of union, amount of union callus, and rate of healing of 35 diaphyseal fractures of long bone femur and tibia in 32 patients with associated severe nerve tissue damage to 40 fractures in 35 patients without head injury, we can understand that union potentialities in the first cohort of patients are higher significantly and long bone fractures of femur and tibia heal more expectedly, better, and faster.^{26–30}

The results of the current study show that osteoblasts have been found in abundance and often, in the majority of the debris of intra-medullary reaming of femur and tibia in patients with associated severe head injury with and these fractures healed rapidly with exuberant union callus without delayed union or nonunion that may reflect that certain mechanism has prepared the fracture environment in these patients with plenty of osteoblasts from local bone marrow and fractures ends and may also form undifferentiated mesenchymal cells of distant bone marrow, which have been homed to fracture site and differentiated into osteoblasts to appear in the reaming debris and to induce adequate and faster healing.^{25,26,31}

5. Conclusion

From the results of the patients recruited in this study, we can conclude that long bone fractures in head injury patients heal more expectedly, faster, and with exuberant and florid callus

formation, which may be attributed to the plenty of osteoblasts in the fracture environment, which have been demonstrated in the reaming debris of intra-medullary nailing for fixation of femur and tibia diaphyseal fractures in these patients. Certain mechanisms could have been stimulated to provide these osteoblasts at the fracture site to induce adequate and faster healing. This mechanism needs further research.

Conflicts of interest

All authors have none to declare.

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