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Effects of Different Fixation Devices on Fracture Treatment and Evaluation by Radiography in Birds

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Abstracts: Twenty star crossbred broilers of 5 weeks age were taken and divided into 4 groups to know the suitable method of fracture immolization. The fixation devices used were adhesive tape with wood splint, intramedullary pinning and dynamic compression plate with cortical screws and one group as control kept in case rest. To monitor the healing status, the radiographs were taken at 3rd, 4th and 6th postoperative weeks. Minimal fracture gap, callus formation and excellent alignment were found in dynamic compression plate. Fracture gap reduces significantly ($P<0.01$) with small callus formation and good alignment in dynamic compression plate group but similar result along with larger callus found in intramedullary group. The present study suggested that dynamic compression plate is the best method for fixation of fractured bone in birds.

Key words: Bone fracture, fixation devices, radiography, birds

Introduction

Balanced feed is prerequisite for growth and maintenance of living beings and deficiency of any ingredient leads to metabolic diseases. Bone is very much vulnerable to various metabolic disorders and one of the consequences is fracture created by external violence. The most frequent causes of fracture are mechanical injury, blows, bite by animals and automobile accidents. One of the most common affections of bone in birds is fracture. Cage rearing birds frequently experienced leg fracture and subsequently wing fracture (Arnall and Keymer, 1975). Remedy of complicated fracture by amputation is practiced in pet animal and rare in bird but exception in reproductive purpose (Gandal, 1971). The repair of fracture can be managed by closed reduction with external support, internal fixation alone and internal fixation with secondary external support. Radiography plays an important role to identify extent of fracture result from disruption of bony continuity and also for confirmation of apposition after immobilization. After immobilization, healing is the only remarkable repair processes of bone in the body. The changes associated with fracture healing are considered a series of stages occur in sequence but in reality overlap to a certain extent (Alexander, 1985).

Repeated radiography and then correction of fracture is required to ensure appropriate apposition randomly practiced in human being and in small animal surgery of veterinary science. There is no such research work on fractures treatment by different devices as well as frequently evaluation by radiography in birds. So, the present work was undertaken to study the suitable method of fracture immobilization in birds which could be evaluated by radiological interpretation.

Materials and Methods

A total of 20 Star Crossbred broilers (*Gallus domesticus*) of 5 weeks old bought from a local poultry farm were used for this study. They were kept at optimum environment and supplied adequate amount of balanced feed and drinking water. All birds were managed in hygienic cage and dewormed by levamisol hydrochloride (Poulnex® 20 gm packet, Animal Health Division, Novartis, Bangladesh Ltd.) at the dose rate of 0.12 mg/kg body weight. After 10 days rearing, the birds were controlled by proper anaesthesia and were subjected to transverse mid-shaft fracture in tarsometatarsal bone. The birds were divided randomly into four groups and the experimental design were as follows:

Group A: All birds of this group were maintained in the cage after producing fracture without application of any physical means for fracture reduction and alignment.

Group B: Fractured birds of this group were immobilized by adhesive tape with wood splint.

Group C: The bone fractures of this group were repaired by using intramedullary pinning.

Group D: Leg fractures of birds of this group were treated by the application of bone plate and cortical screws.

Artificially, fractures were created in group A and B by twisting the tarsometatarsal bone of leg. In group C and D fractures were created by making a longitudinal incision over the muscles of tarsometatarsal bones and then by physical trauma. A 0.2 cm diameter and 5.0 cm long intramedullary pin was inserted through the cortex of the proximal shaft of the bone in group C. The fracture was aligned by bone plate (3.5 X 0.5 cm^2) with screw in group D. Muscle layers and subcutaneous tissues were closed by using medium chromic catgut 2-0 with simple continuous suture. The skin was apposed with nylon thread 2-0, using the simple interrupted suture. Special emphasis was given to prevent contamination of the surgical wound and it was carried out by sealing the wound with cotton soaked by tincture benzoine. On day 35 post-operation, the pin was removed with surgical measures of skin and muscle. Procaine penicillin was injected at the dose rate of 10,000-iu/kg-body weight daily for 5 days through intramuscular route. The data obtained in the present investigation was analyzed using paired student's 't' test.

Radiographs of fracture gap were taken after satisfactory control of each bird by proper anaesthesia.

Radiographs are starting at the time of fracture and continued at 3rd, 4th and 6th week after fracture. The last (6th weeks) radiograph was taken immediately after removal of the fixation device from the body to evaluate alignment and healing process of bone. Radiographic picture of fractures was compared and the results were evaluated by grading the fracture gap with 0 means no gap (excellent healing) and highest value 4 means widest gap (poor healing) by observing fracture reduction, the alignment and the callus formation.

Results

The healing process in fractured bone is interpreted radiographically by different fixation devices (Fig. 1a, 1b, 1c, 1d, 1e, 1f, 1g and 1h). The effect of fixation devices in fracture gap, alignment and callus formations in broilers is presented in Table 1.

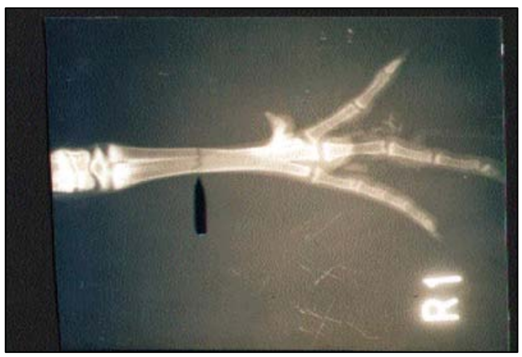

Fig. 1a: Radiographic view of complete transverse fracture of tarsometatarsal bone of bird just after fracture without fixing device (indicated by arrow)

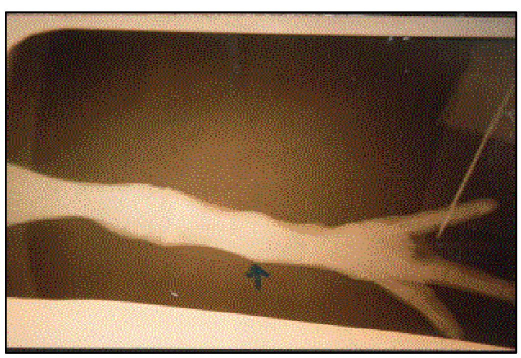

Fig. 1b: Radiographic view of healed up complete transverse fracture of tarsometatarsal bone of bird after 3 weeks without fixing device (indicated by arrow)

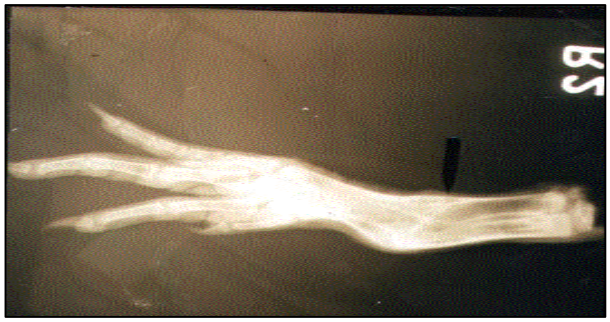

Fig. 1c: Healed up complete transverse fracture of tarsometatarsal bone of bird after 6 weeks without fixing device (indicated by arrow)

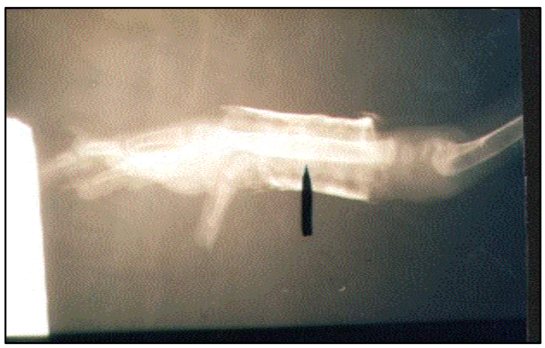

Fig. 1d: Radiographic view of reduced fracture gap of complete transverse fracture of tarsometatarsal bone of bird immediately after fixation with adhesive tape and wood splint (indicated by arrow)

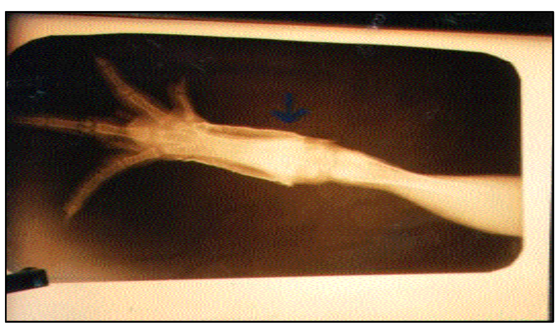

Fig. 1e: Radiographic view of reduced fracture gap of complete transverse fracture of tarsometatarsal bone of bird after 3 weeks of fixation with adhesive tape and wood splint (indicated by arrow)

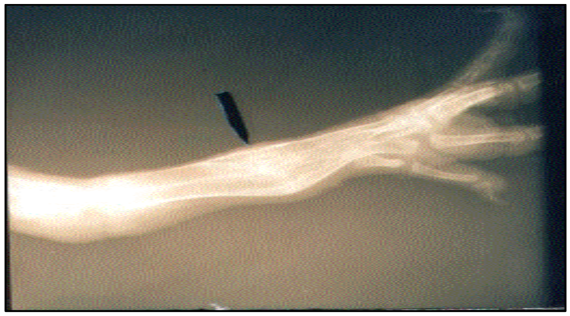

Fig. 1f: Radiographic view of reduced fracture gap of complete transverse fracture of tarsometatarsal bone of bird after 6 weeks of fixation with adhesive tape and wood splint (indicated by arrow)

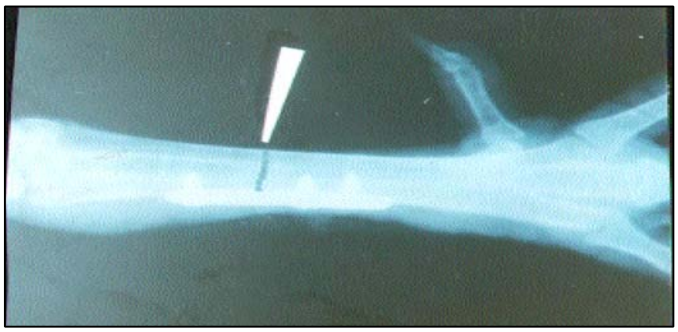

Fig. 1g: Radiographic view of reduced fracture gap of complete transverse fracture of tarsometatarsal bone of bird immediately after fixation with dynamic compression plate with cortical screw (indicated by arrow)

Fig. 1h: Radiographic view of reduced fracture gap of complete transverse fracture of tarsometatarsal bone of bird 3 weeks after fixation with dynamic compression plate with cortical screw (indicated by arrow)

Fig. 2a: Gross view of normal tarsometatarsal bone (left) and healed fractured tarsometatarsal bone (right) without fixation devices at 6 post operative week

Fig. 2b: Gross view of normal tarsometatarsal bone (left), healed fractured tarsometatarsal bone 3 weeks after fracture (middle) and healed fractured tarsometatarsal bone (right) fixing with adhesive tape with wood splint devices at 6 post operative week

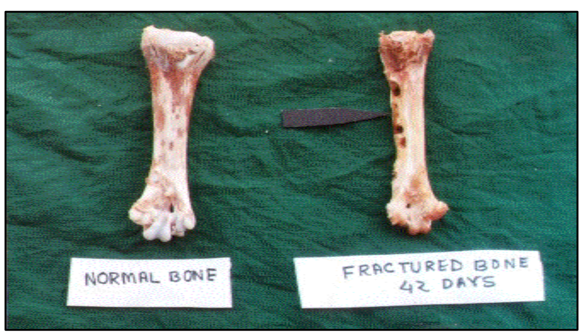

Fig. 2c: Gross view of normal tarsometatarsal bone (left), healed fractured tarsometatarsal bone 6 weeks (right) fixing with dynamic compression plate and cortical screw

The mean value of fracture gap in group A, B, C and D immediately after fixation were 3.13 ± 0.30, 2.4 ± 0.43, 2.35± 0.37 and 1.53± 0.29 respectively, which reduced to 0.3 ± 0.6, 0 ±0, 0 ± 0 and 0 ± 0 at 6th postoperative week. The fracture gap started to reduce significantly ($p < 0.01$) from 3rd postoperative week in all groups.

No callus formed immediately after fixation and gradually started after fixation with devices and the results were 2.90 ± 0.11, 2.10 ± 0.14, 2.00 ± 0.08 and 0.75 ± 0.07, respectively at 3rd postoperative week. These values decreased to 2.77 ± 0.21, 1.30 ± 0.32, 1.40 ± 0.08 and 0.50 ± 0.00 at the end of the experiment. Callus formation significantly ($p < 0.05$) decreased at 3rd post-operative week in all groups except group A. The mean value of the alignment of the fractured limb in group A, B, C and D immediately after fracture fixation were 2.10 ± 0.48, 1.85 ± 0.13, 1.83 ± 0.17 and 1.33 ± 0.41, respectively. These values changed to 2.90 ± 0.40, 1.67 ± 0.38, 1.43 ± 0.10 and 0.85 ± 0.07, respectively after 6 weeks of fracture fixation. The fixation was maintained up to 6th postoperative week and significantly ($p < 0.01$) good alignment was found in the bone plated group (group D) at 3rd postoperative week.

At 42nd day of experiment, healed bones from all the birds were collected (Fig. 2a, 2b and 2c). There was no fracture gap at this stage in all birds but larger callus formation as well as mal-alignment found in group A. However, no fracture gap, little bit callus formation and excellent alignment were formed in group D.

Discussion

Fracture gaps and bony alignment after immobilization as well as callus formation in different fixation techniques were studied. The fracture gap remained larger than moderate gap (3= fair) in cage rest group at day 0 and in other groups below moderate gap. At the same period, relatively more reduced gap was found in dynamic compression plate group. Large fracture gap in cage rest group is due to absence of external support during healing process and this result has been agreed with the earlier investigators (Lillich *et al.*, 1995; Martens *et al.*, 1991). They also postulated that continuous interference at the fracture site due to movement and contraction of muscles on the opposite direction may lead to larger fracture gap. More reduced fracture gap in dynamic compression plate treated group may be due to rigid and accurate apposition of fractured ends. Similar work has been carried out elsewhere (Aithal, 1993; Muir and Norris, 1997; Kumar *et al.*, 1997). After stabilization of the fracture with bone plate and cortical screws, there was no chance of loosening of bony fragments and ultimately lead to safe healing process (Prakash and Singh, 1995; Shivapradash *et al.*, 1997). The fracture gap between the adhesive tape with wood splint and intramedullary pinning were more or less same. But the mean fracture gap (0.39 ± 0.48) of intramedullary pinning was slightly reduced at 3rd postoperative week. The adhesive tape with splint provides adequate reduction of the fracture gap and also held the fragments end in proper apposition which is helpful for unhindered healing. Intramedullary pining on the other hand has the disadvantage of rotational instability resulting in inward or outward rotation of the limb (Alexander, 1985). Whereas, adhesive tape and wood splint provides better alignment. This result is similar to the work of Arnoczky *et al.* (1985). This may be due to external coaption which prevent the deviation of fractured long bone.

There was no callus formation at the time of fracture creation in all groups. Time onward after fracture formation, callus deposited at the end of the fragments. Less callus was formed in dynamic compression plate (DCP) and highest callus found in cage rest group. The reduction of callus formation with DCP is agreeable with the earlier reports (Dubey *et al.*, 1992; Shivaprakash *et al.*, 1997). Increased callus proliferation also found in all birds at 3rd postoperative week and reduced at 6th postoperative week. Reduction of callus formation with DCP might result from rigid fixation of the fractured bone (Prakash and Singh, 1995; Shivaprasash *et al.*, 1997; Mohindroo *et al.*, 1998). They also reported that immediately after fixation, endothelial buds start crossing the fracture gap. It was demonstrated that the amount of cartilage present in the healing process is inversely related to the rigidity of fixation. Increased callus formation with cage rest is also agreeable with the earlier reports (Lillich *et al.*, 1995; Martens *et al.*, 1991). The large callus is due to motion remained at the fracture site and large hematoma (Martens *et al.*, 1991). The callus formation in

Table 1: Effects of different fixation devices on reduction of fracture gap, alignment and callus formation in fractured bone of broilers

Methods of fracture fixation	Post-operative week	Cage rest (A)	Adhesive tape with wood splint (B)	Intramedullary pinning ©	Dynamic compression plate (Bone plate) with cortical screw (D)
Fracture gap	1	3.13±0.30	2.40±0.43	2.35±0.37	1.53±0.29
	3	1.23±0.25*	0.38±0.48*	0.39±0.48*	0.20±0.28*
	4	0.37±0.35	0.07± 0.12*	0.10±0.12	0.05±0.07*
	6	0.30±0.60	0.00±0.00	0.00±0.00	0.00±0.00
Callus formation	1	0.00±0.00	0.00±0.00	0.00±0.00	0.00±0.00
	3	2.90±0.11*	2.10±0.14	2.00±0.08	0.75±0.07*
	4	2.93±0.21	1.50±0.35*	1.93±0.09	0.55±0.07
	6	2.77±0.21	1.30±0.32	1.40±0.08*	0.50±0.00*
Alignment of fracture	1	2.10±0.48	1.85±0.13	1.83±0.17	1.33±0.41
	3	3.00± 0.10	2.00±0.35	1.95±0.13	1.10±0.14*
	4	2.93±0.11	1.73±0.23	1.65±0.06	0.88±0.04
	6	2.90±0.40	1.67±0.38*	1.43±0.10*	0.85±0.07

0= excellent, 1= very good, 2= good, 3= fair, 4= poor. ± Standard error * Significant (p<0.01)

adhesive tape with wood splint and intramedullary pinning groups is negligible. This result is agreeable with the earlier reports (Schneider *et al.*, 1995; Thilagar *et al.*, 1997). The mild (good) callus formed in adhesive tape with wood splint group is due to reduced fracture gap and rigid fixation of fragments (Alexander, 1985). The negligible amount of callus formation in intramedullary pining is due to good lateral stability provided by the pin fits in the medullary cavity snugly (Stick *et al.*, 1980). All the effects were evaluated by radiography in the living birds and grossly after disposal. Radiographical assessment is accurate and the resultant factors are presented in scoring system. Therefore, we concluded that both intramedullary pining and adhesive tape with wood splint are the best devices for fracture fixation in birds but intramedullary pin was excellent method as it does not loosened before healing like adhesive tape with wood splint. But formation of callus in these groups could not be prevented. So, DCP is the best method for fixation of bone fracture in birds.

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