CLINICAL EVALUATION OF BIOGLASS FOR AUGMENTING FRACTURE HEALING IN DOGS*

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Abstract

Six dogs irrespective of age, sex, breed and limb affected with fracture of long bones were subjected to clinical and radiographical evaluation. Intramedullary pinning using steinmann pin was done for primary stabilization of fracture and interfragmentory voids were filled with bioglass granules. Clinical, haematological, biochemical and radiographic evaluation of fracture healing were performed pre-operatively and post-operatively on 15th, 30th and 60th day. The study concluded that bioglass could be used as a filling material for augmenting fracture healing in long bones in conjunction with primary stabilization.

Keywords: *Bioglass granules, fracture of long bone, augmentation of fracture healing*

Fracture of long bones are the common orthopaedic condition encountered in dogs and among this ten percent of the fractures require grafting for filling interfragmentory void at the fracture site (Van der Stok *et al.,* 2011). Bioactive glasses are synthetic bone graft substitute with superior bone to graft bonding and no tissue reaction. It provides support for faster bone healing, acting as scaffold for regeneration of bone by forming hydroxy apatite layer through leaching of mineral ions into solution when in contact with blood or saline and act as bridging between bone and graft (Chen *et al.,* 2008).

Materials and Methods

The clinical study was conducted in six dogs having fracture of long bone with fragmentation presented for treatment (Table 1). Clinical and radiographic evaluation was carried out pre-operatively prior to intramedullary pinning and bone grafting with bioglass granules. Retrograde intramedullary pinning was done in five animals and normograde intramedullary pinning in one animal. The fragments with no muscular attachments were removed and the interfragmentory voids were filled with bioglass ceramic granules premixed with normal saline (Fig. 1). The animals were observed for 60 days to assess clinical, haematological, biochemical and radiographic evaluation. The filling of interfragmentory void and subsequent healing of fracture was evaluated post-operatively on 15th, 30th and 60th day. Haematological and

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serum biochemical evaluation was done pre-operatively and post-operatively on 15th, 30th and 60th day to assess the systemic changes following grafting. The operated limb was immobilized with plaster of paris cast post-operatively.

Results and Discussion

Out of the six dogs, five cases were managed post-operatively without complications. Moderate weight bearing on the operated limb was observed in all dogs by 15th post-operative day. Complete weight bearing was observed in all the dogs by 30th post-operative day except in one dog which had migration of intramedullary pin. The pin was removed on 45th post-operative day for further observation and the dog exhibited near to normal weight bearing by 60th post-operative day.

Table 1. Anamnesis of cases

Case No.	Breed	Age	Sex	Type of fracture
1	Non-descript	10 months	Male	Simple complete short oblique overriding fracture
2	Rottweiler	4 years	Female	Simple complete oblique fracture
3	Rottweiler	2 years	Male	Simple comminuted
4	Non-descript	6 months	Female	Simple complete short oblique overriding
5	Non-descript	6 years	Male	Simple complete short oblique
6	Non-descript	10 months	Male	Simple complete short oblique overriding

Table 2. Physiological parameters (mean ± SE) of the cases under study

Parameter and units	Day of observation			
	Pre-operative	15th day	30th day	60th day
Respiration rate (per minute)	30.00 ± 1.06	29.33 ±1.28	28.66 ± 1.40	29.50 ± 1.28
Pulse rate (per minute)	93.00 ± 3.08	90.66 ± 2.35	91.00 ± 2.35	91.00 ± 2.67
Rectal temperature (^{0}F)	102.26 ± 0.39	101.71 ± 0.31	101.70 ± 0.23	101.65 ± 0.14

Table 3. Haematological evaluation (mean ± SE)

Parameter and Unit	Day of observation			
	Post-Operative	15th day	30th day	60th day
Haemoglobin (g/dl)	11.08 ± 1.04	11.53 ± 0.95	12.73 ± 0.37	12.91 ± 0.33
Packed Cell Volume (%)	33.46 ± 3.22	33.33 ± 1.92	35.00 ± 1.53	35.50 ± 1.23
Erythrocyte Sedimentation Rate (mm/h)	7.20 ± 0.64	6.60 ± 0.56	5.90 ± 0.39	5.70 ± 0.60
Total Leucocyte Count (10^3 /cumm)	13.50 ± 1.25	11.55 ± 0.26	11.05 ± 0.38	10.36 ± 0.23

Table 4. Serum biochemical evaluation (mean ± SE)

Parameter and Unit	Day of observation			
	Post- Operative	15th day	30th day	60th day
Serum calcium (mg/dl)	10.63 ± 0.75	11.05 ± 0.69	10.85 ± 0.49	10.51 ± 0.43
Serum phosphorus (mg/dl)	4.16 ± 0.24	3.85 ± 0.08	3.60 ± 0.02	3.53 ± 0.07
Serum alkaline phosphatase (IU/L)	79.17 ± 7.76	121.33 ± 5.95	101.83 ± 3.11	88.5 ± 2.62

The physiological parameters like rectal temperature, pulse rate and respiration rate (Table 2) and haematological parameters like haemoglobin concentration, packed cell volume (VPRC), erythrocyte sedimentation rate and total leucocyte count were within normal range though there were variations observed during the post-operative period (Table 3). The biochemical parameters like serum calcium and serum phosphorus did not show any variation except total serum alkaline phosphatase which was increased from normal values on second week and there after it became normal in subsequent observations (Table 4). This is in accordance with findings of Kamnenou *et al.* (2005) and the increase in serum alkaline phosphatase activity was due to rapid formation of fibroblast and new bone.

Radiographically bridging callus was observed in all the dogs and the interfragmentory space appeared with reduction in density in early post-operative radiograph (Fig. 2) except in one dog where there was large callus due to instability resulting from pin migration. Progressive filling of fracture site with new bone was observed as evidenced by increase in density. Complete healing of fracture was noticed by 60th post-operative day with filling of interfragmentory voids (Fig. 3.). This finding is in acoordance with observations of Gosain (2004) and Valimaki and Aro (2006).

From this study it was concluded that the bioglass readily formed scaffold for new bone formation leading to early formation of bridging callus and early healing of fracture. Physiological, haematological and biochemical values did not show significant variation except alkaline phosphatase indicating implant acceptance. Scaffold formed by bioglass was stable and promoted osteoconduction and osteointegration leading to early formation of callus.

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Fig. 1. Comminuted fracture of femur. Arrow denotes the removed fragment

Fig.2. Immediate post-operative. Arrow denotes reduced radio-opacity

Fig. 3. 60th day post-operative. Arrow denotes regained radio-opacity

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