RADIOGRAPHICAL EVALUATION OF Sr-HASi BIOCERAMIC SUBSTITUTE FOR CRITICAL SIZE BONE DEFECT IN A GOAT – CLINICAL STUDY

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Abstract

Strontium (50%) incorporated calcium hydroxyapatite coated with silica based ceramic (Sr-HASi) is a biodegradable graft substitute used in the treatment of bone defects and osteoporotic conditions. The material was reported to degrade in par with the regrowth of bone tissue, but a long term clinical study to assess the fate of the material was lacking. The study was done in a two month old male Jamunapari cross bred kid with distal comminuted fracture of metacarpal bone and treated by bioceramic graft substitution. Radiography was used for evaluating the changes of the graft and time taken for degradation, along with evaluation of bone healing. Postoperative orthogonal views of the graft substituted bone was taken on 2nd, 4th, 6th, 8th and 24th week after surgery. The graft was found to remain stable and completely radiopaque till 4th week and thereafter signs of gradual degradation could be noticed. On the radiograph taken after twenty four weeks, the central core of the graft material got completely degraded leaving only the peripheral outline. The graft material remained intact and well incorporated within the bony callus till the secondary callus development was complete and degradation was noticed once the remodelling process has started. Hence, it was concluded that complete resorption of the material might require more than six months in a clinical situation.

Keywords: *bioceramic graft, Sr-HASi, comminuted fracture, critical size defect*

Bioceramic graft substitutes find wide range of applications in veterinary clinical practice like correction of bone defects resulting from dissection of bone tumours, osteomyelitis, severe comminuted fractures and osteoporotic diseases. Silica based ceramic coated calcium hydroxyapatite incorporated with strontium (Sr-HASi) was one such bioceramic graft with the property of porosity (Campana *et al*., 2014), radio opacity, osteoinduction and osteoconduction. The graft material augments the healing process by stimulating the proliferation of osteoblasts (Zhang *et al*., 2010) and undergoes gradual degradation in par with

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osteogenesis(Nair *et al*., 2009). The study was intended to evaluate the fate of the material after being incorporated into the bone, using radiological means, for a period of six months.

A two month old Jamunapari kid was presented to the Teaching Veterinary Clinical Complex, Pookode, Wayanad, Kerala, with the history of acute lameness, after its left forelimb got trapped between the wooden planks of the goat pen. The animal was diagnosed with comminuted fracture of distal metacarpal bone, after clinical, orthopaedic and radiographical examination. The limb was temporarily immobilized with soft bandage and for pain management, meloxicam[1] was given subcutaneously at the dose rate of 0.2 mg/kg body weight. Tetanus toxoid injection was also given, intramuscularly and was kept on fasting for six hours before surgery on the following day.

Materials and Methods

Surgical correction of the comminuted fracture was performed under general anaesthesia with midazolam[2] and ketamine[3] (at the dose rate of 0.25 mg/kg and 4 mg/kg body weight respectively) 20 minutes after butorphanol[4] and xylazine[5] premedication. A craniolateral approach was chosen for exposing the affected bone. The loose comminuted bone fragments were removed and fractured bone edges were debrided, resulting in a defect of critical size, which was substituted with Sr-HASi graft of equal size. The graft was retained in position by apposing the surrounding soft tissues over it (figure 1). Post-operatively the bone was immobilized by external coaptation using plaster cast.

Immediately after surgery orthogonal views of radiographs were taken to confirm the apposition and alignment of fracture fragments. Follow-up radiologic evaluation of bone healing was conducted at 2nd, 4th, 6th, 8th and 24th weeks after surgery.

Results and Discussion

The graft material, that has increased radioopacity due to the presence of 50 % strontium, was found intact and was bridging the critical size defect in the immediate postoperative radiograph (figure 1). There was a zone of radiolucency around the material. On each follow-up observation the amount of degradation of the graft was observed along

Fig 1. Substitution of graft and postoperative radiographs

Substitution of graft

Immediate post operative

After 4 weeks

After 8 weeks

After 24 weeks

1 MELOBEST™vet (5 mg/ml) – TTK Healthcare Ltd., Old Trunk Road, Chennai.
2 MEZOLAM (5 mg/ml) – Neon Laboratories Ltd., Boisar road, Thane.
3 ZOKENT (50 mg/ml) – Aesmira Miraculus Pharma Pvt. Ltd. Andheri, Mumbai.
4 BUTODOL (1 mg/ml) – Neon Laboratories Ltd., Boisar road, Thane.
5 XYLODACTM-Vet (20 mg/ml)- Zydus Animal Health, Ahmedabad.

with bone healing. On second week, the graft was found intact superimposing the periosteal reaction on cranial side of the defect while periosteal callus and bridging on the caudal side were visible radiographically. On 4th week observation, almost complete bridging of the bone defect with graft incorporation within the bony callus could be detected (Figure 1). Bridging of the defect by callus could be detected from the decreased amount of radiolucent area around the graft (Nair *et al*., 2009). By 6th week observation, signs of remodelling of bone could be detected in both views of radiograph. Together with this, reduced radio opacity of the graft material, which was indicative of increased porosity due to graft resorption, was also detected. This trend was followed in the 8th week observation also. The graft was found to have increased porosity and osteolytic changes were found around the material. Concurrent clinical and orthopaedic evaluation of the animal showed significant decrease in lameness after six weeks and returned completely back to normal mobility after eight weeks (Fig. 1). After 24 weeks, remodelling of bone was found almost complete with increased radiolucency of the material. The central core of the material got completely degraded with peripheral outline remaining (Figure 1). Lengthening of bone and proximal shifting in the position of graft could also be appreciated in the radiographs.

Nair *et al*., (2009) reported that reduction in radioopacity of the graft was an indication for osteogenesis through the pores of the graft and degradation of the material. Using periodical radiographs we were able to observe that the graft material underwent gradual progressive degradation in par with osteogenesis and bone remodelling. Hence, it was concluded that complete resorption of the material might require more than six months in a clinical situation.

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