European Cells and Materials Vol. 5. Suppl. 1, 2003 (pages 28-29) ISSN 1473-2262

# RADIOGRAPHIC AND HISTOLOGIC EVALUTATION OF INTRA-ARTICULAR CALCIUM PHOSPHATE CEMENT IN A RABBIT MODEL

Ch. Braun[1], B.A. Rahn[1], R. Wieling[1], M. Fulmer[2], A. Gisep[1]

[1] *AO Research Institute, Clavadelerstrasse, 7270 Davos Platz, Switzerland*
[2] *Synthes (USA)* 1230 Wilson Drive, West Chester, PA 19380, USA

**INTRODUCTION:** Orthopaedic trauma surgeries often require bone grafting for void filling after comminuted articular fractures, tumor resection or contouring in the cranio-maxillofacial area. Besides autologous bone grafts, there are various possibilities like polymeric or ceramic blocks or granules that can be implanted. In comminuted articular fractures (e.g. Colles fracture) ceramic calcium-phosphate cements are used to support the realigned articular surface. At the application of the viscous cement paste, the material might penetrate into and set as a mass in the intra-articular space. The clinical outcome of this situation is widely unknown.

The present study addressed the issue of intra-articular ceramic calcium phosphate cement in a rabbit model. Parameters like inflammatory reactions, appearance of the cement or direct abrasion of the articular surfaces by the injected cement are investigated clinically, radiologically and histologically.

**METHODS:** The experiments were carried out in 18 white New Zealand rabbits (age of 17 months) with a weight of 4.4 ± 0.4 kg (permit GR 01/2000). The animals were divided into groups of 3 with observation periods of 1, 4, 12 weeks, and 6, 12 and 18 months. Implantation of the cement was done under aseptic conditions and general anaesthesia. Through a percutaneous approach after a stab incision, a blunt 12 ga needle was introduced into the tibio-femoral joint space. On the right leg, 0.01 ml of Norian®SRS® Bone Cement was injected through a 14 ga needle via plunger displacement. This amount is equivalent to 0.3ml in a human knee joint based on estimated comparative body weight.

On the left knee, the same volume of ringer-lactate solution was injected with the same approach to the joint space. The incisions were closed with a single suture. Post-operative and 6, 12 and 18 months follow-up x-rays were taken in anteroposterior and mediolateral direction. For the first two post-operative weeks, the animals were kept in single boxes without food restrictions. For the rest of the observation period, all animals were kept in one group on straw. General health was monitored weekly by the animal keepers. At completion of the observation time, the rabbits were sacrificed with an overdose of barbiturates (Vetanarcol®) given intravenously. Both knees were harvested and fixed in 70% ethanol. Histological processing included PMMA embedding, 200 µm sectioning, macroradiographs and Giemsa-Eosin staining. Light microscopic evaluation was performed on a Zeiss Axiotech microscope with digital image acquisition (Zeiss AxioCam, AxioVision Ver. 3.1).

**RESULTS:** All animals recovered well within one day of the surgery. Clinically, there were no signs of inflammation of the knee joints: no swelling nor heat generation was detected. The animals were not limited in their movements. On the postoperative x-rays, the injected cement was clearly visible in the right knee joint and, in the follow up, no signs of degeneration could be seen. In the contact radiographs of the histological sections, the location of the cement mass could be determined. In 1/18 cases, the cement was found in the lateral aspect of the joint capsule, away from the contact areas of the articular cartilage. In 13/18 cases, the material was detected mainly anterior of the cruciate ligaments and focused on more or less one point in the joint cavity. The biggest mass found was about 3.4x1.4 mm. In 4/18 cases, the material was fragmented and scattered over the whole joint, where as in 3/4 the main content can be found in the posterior region. These findings were independent of the observation period.

In all cases, the synovial tissues formed layers around the clots from the beginning of the experiment. In the 4 weeks specimens it can be seen how the synovial villi cover the cement and exclude the material from the cavity and its articular surface. Synovial cells were found in cracks in the cement. After 6 months, formation of cartilage and ossification around the material occurs. In the 12 and 18 months specimens, superficial degeneration of the cement by synovial histiocytes can be seen, followed by ossification. At no time can strong, acute or chronic inflammation be detected. No signs of arthritis are seen. The synovial membranes proliferate only slightly in a few cases.

Both in the cement injected joints as in the contralateral control side, only moderate deterioration can be found of the cartilage and the cruciate ligaments. Some of these alterations can be definitively determined to be caused by cement. Some of them are most likely caused by the injection procedure itself.

**DISCUSSION & CONCLUSIONS:** The injected amount of cement did not cause major harm to the articular tissues, joint capsule and cartilage in the rabbit's knee over the observation period of 18 months.

However, the effects of the ongoing ossification and the fate of the newly-built bone substance remain unclear as well as what happens with the rest of the cement.

This should be investigated in a longer follow-up, over as many as 5 years.

**ACKNOWLEDGEMENTS:** The author wants to thank Synthes (USA) for providing the implant material.