Experimental osteoarthritis in a stable knee joint using a critical size defect in an ovine model

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Introduction: Osteoarthritis is a degenerative joint disease leading to pain, swelling and immobilization and is becoming increasingly more common in younger patients. As OA develops over years, regenerative surgical therapies at the onset stage of OA have become highlighted recently. Animal models simulating osteoarthritis are often associated with irreversible changes of the biomechanics-like ligament transection or meniscectomy. Although these models successfully induce osteoarthritis, the results of experimental repair procedures are impaired by the persistent biomechanics problem (1). The aim of this study is to define the critical size of a chondral lesion to induce osteoarthritis in a stable joint, allowing a more reliable comparison of cartilage repair procedures (4).

Materials and Methods: 16 mature Austrian mountain sheep with a physiological joint status were divided randomly into four treatment groups (Group A: 7mm/6weeks, Group B: 14mm/6weeks, Group C: 7mm/6weeks and Group D: 14mm/12weeks). The sheep were at an average age of 3.6 years (+/-0.6 standard error of the mean; SEM) and a weight of 65.8 kilogramm (+/-3.8 SEM). In each group a full thickness chondral cartilage defect was created with a punch in the weight bearing area of the right medial femoral condyle, without luxation of the patella via a medial compartment surgical approach. The cartilage tissue within the punch margin was curettaged, the defect was levelled to the tidemark and no bleeding occurred within the defect. The diameter of the defects was 7 or 14 millimetres. The sheep were fully weight bearing mobilized for six and twelve weeks. Osteoarthritis was determined by gross assessment (3), India-ink staining (2), histores. The sheep were fully weight bearing mobilized for six and twelve weeks. Osteoarthritis was determined by gross assessment (3), India-ink staining (2), histores. The sheep were fully weight bearing mobilized for six and twelve weeks. Osteoarthritis was determined by gross assessment (3), India-ink staining (2), histores. The sheep were fully weight bearing mobilized for six and twelve weeks. Osteoarthritis was determined by gross assessment (3), India-ink staining (2), histores. The sheep were fully weight bearing mobilized for six and twelve weeks. Osteoarthritis was determined by gross assessment (3), India-ink staining (2), histores. The sheep were fully weight bearing mobilized for six and twelve weeks. Osteoarthritis was determined by gross assessment (3), India-ink staining (2), histores. The sheep were fully weight bearing mobilized for six and twelve weeks.

Results: A cumulative 0.5 (+/-0.1 SEM) GA-score was found in the anterior medial femoral condyle for group A, 1.3 (+/-0.2) for group B, 2.0 (+/-0.1) for group C and 1.3 (+/-0.1) for group D. For the posterior condyle the scores were 0.8 (+/-0.1) group A, 0.8 (+/-0.1) group B, 1.8 (+/-0.1) group C and 1.3 (+/-0.1) group D. For the tibial plateau the scores were 1.0 (+/-0.2) for group A, 1.3 (+/-0.2) for group B, 0.5 (+/-0.2) for group C, 2.0 (+/-0.1) for group D and the Mankin score for the right medial meniscus were 0.8 (+/-0.1) for group A, 0.3 (+/-0.1) for group B, 0.5 (+/-0.2) for group C and 1.8 (+/-0.3) for group C.

The India Ink-Staining scores were multiplied by the zones evaluated, resulting in a scoring from a minimum of nine (no staining) to a maximum of 27 points. The sores were 9.5 (+/-0.3) for group A, 11.0 (+/-0.5) for group B, 15.3 (+/-0.6) for group C and 11.3 (+/-0.8) for group D. For the corresponding medial plateau the sores were 1.0 (+/-0.2) for group A, 1.3 (+/-0.2) for group B, 0.5 (+/-0.2) for group C and 1.8 (+/-0.3) for group C.

The histological evaluation revealed a Mankin-score for the right medial femoral condyle (see Fig.2) of 1.7 (+/-0.2) for group B, 2.7 (+/-0.2) for group B, 5.5 (+/-0.1) for group C and 2.4 (+/-0.3) for group D. The OARSI score for the same region showed 1.1 (+/-0.2) for group A, 2.2 (+/-0.2) for group B, 5.2 (+/-0.9) for group C and 1.1 (+/-0.2) for group D. The corresponding medial plateau revealed a Mankin score of 2.7 (+/-0.3) for group A, 5.9 (+/-0.8) for group B, 4.3 (+/-0.2) for group C, 6.9 (+/-0.4) for group D and the OARSI score 1.9 (+/-0.3) for group A, 6.2 (+/-1.2) for group B, 5.2 (+/-0.3) for group C and 7.1 (+/-0.6) for group D.

Histologic evaluation of the meniscal tissue yield an average score of 0.7 (+/-0.1) for group A, 1.2 (+/-0.1) for group B, 0.6 (+/-0.1) for group C and 1.7 (+/-0.1) for group D.

Discussion: In the six weeks group only minor osteoarthritis was detected in both defect sizes. After 12 weeks the seven millimetre defect created focal monocompartmental OA at the medial femoral condyle with minor degenerative changes at the corresponding tibia. The 14mm defect induced minor OA at the femoral condyle, but created major degenerative changes on the tibial cartilage and meniscal tissue. A 7mm full thickness chondral defect with a weight bearing loading regime of 12 weeks can be considered as a suitable animal model to induce OA in an otherwise stable joint.


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