Introduction. Active and aggressive benign bone tumours compromise the structural integrity of bone by bone destruction and may lead to pathological fractures. After intralesionally curettage, local adjuvant therapies, such as phenolization, polymethylmethacrylate packing or cryosurgery, may be used in order to extent the surgical margin to achieve adequate tumour-control. Particularly cryosurgery is known for its good cytotoxic capacity. However, spontaneous post-operative fractures are frequently reported after adjuvant cryosurgical treatment of bone tumours. These fractures are caused by the reduced strength due to the treatment and by the reduction in strength due to bone remodelling during the repair phase of the bone. Impaction bone grafting is a well-known therapy to restore the bone stock in revision surgery after failure of hip endoprosthesis. In this study we investigated the effect of cancellous bone grafting on the reduction of bone strength after creating a cryosurgical lesion in the femur of the goat.

Materials and methods. 93 skeletally mature Dutch milk goats (Capra Hircus Sana) were used. In 31 animals a standardised gap (4.5 mm diameter) defect was created in the lateral femoral cortex with a cylindrical diamond drill. These animals served as controls. In 31 animals a needle mounted thermocouple was placed in the cortex at 5.75 mm from the lining of the defect for continuous registration of local temperature and these animals received adjuvant cryosurgical treatment at the margin of the defect, using a closed liquid nitrogen cryosurgical system (Erbokryo SN, ERBE Elektromedizin GmbH, Tübingen, Germany). Three freeze/thaw cycles of 15 minutes each were performed with a cryoprobe. For each cycle the freeze time was adjusted in order to reach a minimum temperature of -10°C at the location of the thermocouple needle, creating a circumferential osteonecrotic margin of 6 mm wide. In an additional 31 animals the defect was after the cryosurgical treatment filled with impacted morsellized autograft harvested from the iliac crest. In each group, four animals were sacrificed at each time intervals of 0, 13, 16, and 24 weeks, and five animals at each time intervals of 4, 7, and 10 weeks. All paired specimens were used for radiography, Computed Tomography and mechanical analysis, whereas two samples of each time interval were assessed histologically.

Radiographic and Computed Tomography analysis. Computed Tomogram, with a slice thickness of 1 mm was made at the centre of the cortical defect (Stratec XCT-960A, Stratec Medizintechnik GmbH, Birkenfeld-Gräfenhausen, Germany). To quantify the bridging of the cortical gap defect and the apposition of new bone tissue, we measured the area of necrosis, remodelling of the necrotic bone, apposition of new bone tissue, and signs of infection.

Histological analysis. After mechanical testing, specimens were fixated in 4% formaldehyde solution and processed for histology. Multiple sections of each specimen were taken to minimise inadequate sampling. Sections were stained with haematoxylin and eosin (HE) and examined for extent of necrosis, remodelling of the necrotic bone, apposition of new bone tissue, and signs of infection.

Results. A significantly lower bone strength was measured at 4, 7, and 10 weeks after cryosurgery compared to controls (Fig. 1). Bone density of the cryosurgically treated femurs is compromised, as compared to controls. This can be explained by the remodelling process of the necrotic cortex, which results in a longstanding increase in porosity. Besides, cryosurgery results in a delay of apposition of new bone at the site of the lesion, which otherwise would have contributed to bone strength, counteracting the negative effect on the mechanical strength of the increased porosity. Cancellous bone grafting does not accelerate healing of cryosurgically treated, stable diaphyseal defects in the goat. Lack of mechanical loading, probably more than cryosurgically induced compromised perigraft environment, accounts for the failure of the graft.

Discussion. Between 4 and 10 weeks postoperatively the mechanical strength of the cryosurgically treated femurs is compromised, as compared to controls. Can cancellous bone grafting has no effect on the reduction of strength of long bones after cryosurgery; a study in the femur of the goat.