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RADIOLOGICAL PICTURE OF THE KNEE AFTER RECONSTRUCTION OF THE ANTERIOR CRUCIATE LIGAMENT IN THE DOG

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The authors investigated the radiological picture of the knee in dogs after reconstruction of the anterior cruciate ligament (ACL) with carbon fibers or fascia lata autograft. The allografts were inserted to replace the ACL according to the modified technique of Jones (Patsama) with autografts or by intraarticular placement of a carbon ligament prothesis as recommended by the manufacturer.

The radiological picture was evaluated after 1, 2, 4 and 6 months. No marked degenerative changes, were found and the tunnel was not replaced by bone tissue. In this experiment, there was no radiological evidence for the superiority of the carbon fiber prothesis over autograft tissue as a substitute for the ACL in the experimental model of the dog.

Key words: carbon fibers, radiology, cruciate ligaments, knee

INTRODUCTION

The anterior and posterior cruciate ligaments provide the knee support which, together with the capsular ligaments, make up the so called passive stabilizers and, with the muscles as active stabilizers, from the soft tissue complex of the knee. In the light of the speed (with which it takes place of movement), the muscles remain of secondary importance while the ligaments are the basic protective system, the cruciate being most important (Alm et al. 1974. Dahlestadt and Dalen, 1989, Johansson et al., 1991.). Thus, ligament lesions and their sequelae are a diagnostic and therapeutical problem which has long been present in orthopaedic and veterinary practice. Numerous data, in the literature, contradictory opinions and the many methods used in the reconstruction of the ligamentous apparatus of the knee, suggest that the problem has not been solved (Cotton and Morrison 1985, Dahlestadt et al. 1989.Gollehon and Warren 1985, Groves 1980, Johnson 1983, Kennedy, 1983, Strum et al., 1989, Trembley et al. 1980). We report only the radiological segment of an experimental study comparing the value of autologous transplant - fascia lata and allografts - carbon fibers for substitution of artificially lesioned ACL in dogs.

MATERIAL AND METHODS

A group of 20 skeletally mature male dogs (German shpherd), aged 1.5-2 yrs and weighing 23-35 kg, were provided by a military breeding farm, for the experiment. They had been trained for military purposes and before inclusion in the study they were regularly immunized and their health was verified by clinical and laboratory investigation. The dogs were kept at the Institute for Experimental Surgery of the Military Medical Academy and at the Veterinary Faculty. They were with Dogal standard food and sacrificed using Hoechst T61.

The experimental animals were divided into two groups, according to the type of graft used to replace artificially lesioned ACL: group I(10 dogs) had a carbon fiber allograft, and group II (10 dogs) had a fascia lata autograft sitted. The following procedures were used: preoperative preparation of the animals, the operative approach, surgical technique of intraarticular resection of the ACL and replacement with a band of fascia lata, 2cm wide and 10-12 cm long or tunnel formation and intraarticular positional placement of the carbon ligament with the ends fixated with Blaunt's clamps.

Postoperatively, the following studies were conducted: clinical, laboratory, biomechanical, radiological and pathohistological.

The radiological investigation included postoperative X-ray of the knee at I, 2, 4 and 6 months, depending on the time of sacrifice of the animal. The last X-ray was made immediately before sacrifice. The healthy knee of the same dog served as the control. Standard Philips X-ray equipment and "Agfa Gevaert" film, 24x30 cm were used for recording. Focus-to-film distance was 50 cm, Rat 0.7 diaphragm was used. The Anesthetized animal was X-rayed in two basic projections: anteroposterior (AP) and mediolateral (ML) and a stress scan was also taken. In addition, the knee was X-rayed during the drawer test using the manual method. The anterior movements of the tibia (drawer sign) were measured in the following way: the first line was drawn along the posterior edge of the tibia (No), the second was parallel to it through the posterior point of the lateral femoral condyle (lc) - on the cross section with Blumensaat's line, while the third went through the posterior tibial condyle (lt) (figure 1). Normally, lc and lt overlap, but in the cases of the positive drawer sign they are separated by several mm. Imaging was performed with X-rays of 50kV and 20 mA using an exposure time of 0.06 sec. Radiographic studies were used for monitoring of following parameters:

1. Appearance of the bones making up the knee, femoral and tibial tunnels;

2. Position of the patella - the indirect condition of the capsule and the presence of effusions in the knee,

3. Metal shadows of the clamps,

4. Appearance of the interarticular space with a description of the possible presence of narrowing of the space, subchondral sclerosis, osteophytes and other characteristics of osteoarthritis;

5. Appearance of the soft tissue shadow.

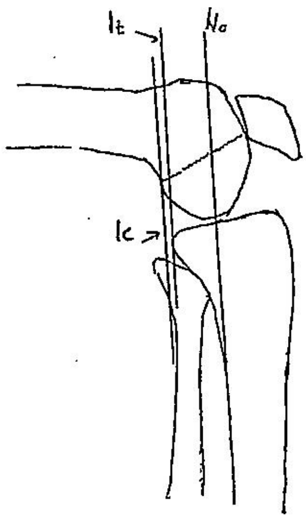


Figure 1. Determinat;ion of the amount of anterior translation of the tibia in the manual anterior deawer test (explanat;ion in text)

RESULTS AND DISCUSSION

The X-ray investigation included all operated knees of the dogs in both groups, with the contralateral knee as a control, as already stated. X-ray imaging was repeated 1, 2, 4 and more months after the surgery.

X-Ray findings in group i carbon fiber prothesis) At the first check, a month after the operation, AP X-rays revealed transillumination in the distal femoral metaphysis, 0.4 cm wide projecting into the medial part of the intercondylar fossa, while the metal shadow of the clamp was seen on the external side of the lateral condyl. Similar canalicular transillumination was projected on the proximal tibial metaepiphysis. Distally from the tunnel-like transillumination the metal shade of the clamp was seen anteromedially in the proximal tibia. At this time a change in the width of the articular space was seen in one dog only (No.5), while the space remained unchanged in the remaining ones when compared to the control healthy contralateral knee. The soft tissue shadow of the operated knees was mildly enlarged.

Lateral images (ML projections) revealed transillumination of these tunnels both in the distal femur and proximal tibia. The metal shades of the clamps were clearly visible on both the femur and tibia, while migration was noted in one dog only (No. 9). In all others the position of the clamps was unchanged as related to the initial state when the clamps were put in place. In ML projection, the position of the patella on the operated knee was altered when compared to the control joint, i. e. the patellar femur surface, which suggestd the presence of intraarticular effusion. The soft tissue shadow was also enlarged, especially proximally to the patella, while distally the shadow was smaller. Anterior translation of the tibia on the stress image was 10mm on average. (Figure 2).

On the X-ray taken at the second check (two months after surgery) - the findings was mainly unchanged compared to those at the first follow-up a month earlier. X-rays, obtained 4 and more months after surgery revealed minor tran-

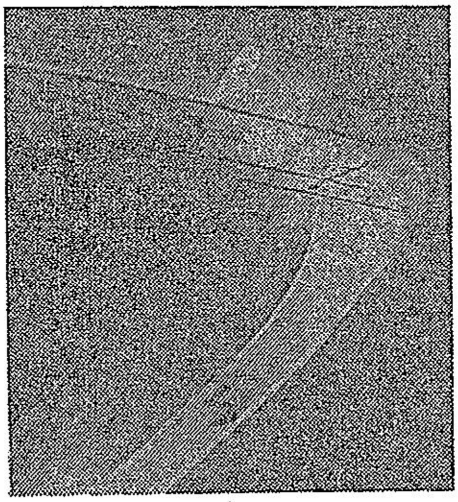


Figure 2. Stress image of the carine knee, one month after the operation (ACL replaced by carbon fibers) - increasing anterior translation to 10 mm

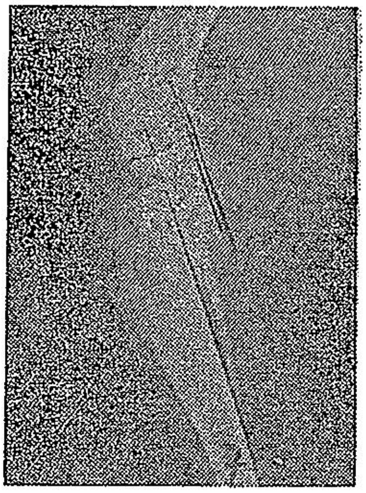
sillumination at the site of osseous tunnels in the distal parts of the femur and proximal part of the tibia marked on both AP and ML projections. There was no edema of the soft tissue or signs of effusion. The intraarticular space was narrowed only in one dog (No. 7). The stress image showed tibial translation of greater than 2-3 mm on average as compared to the first and second examinations.

X-RAY FINDINGS IN THE SECOND GROUP AUTOGRAFT-FASCIA LATA) The findings a month after the surgery in AP projection revealed transillumination of the artificially modelled tunnel in the distal part of the metaepiphysis of the femur and proximal tibia through which the band of fascia lata was pulled. These channels in all dogs in this group went from the medial side of the proximal part of the distal tibial diaphysis towards the interarticular space (fossa intercondylica of the femur) of the knee and further towards the femoral lateral condyl. In one case (dog No. 12) a tiny sequestrum separated from the lateral condyl was noted at the exit from the osseous tunnel. The position of the patella was unchanged, but soft tissue edema was noted. The interarticular space at this check was changed as compared to the normal knee (Figure 3a).

Two months after the surgery, the findings in the operated knees were similar to those in the first group. Stress images revealed anterior translation of the tibia by an average of 9. 3mm (Figure 3b).

Four and more months after surgery (group 3), AP and ML projections of the knees of the experimental animals still revealed transilluminations at the sites of artificially formed tunnels in the femoral and tibial metaphysis. The interarticular space was narrowed only in two cases (No. 14, 17), while stress images showed that anterior tibial translation was 4mm on average.

The dog's knee is an adequate model for experimental surgery, as used in the studies of O'Donoghue et al. (1971), McMaster (1985), Marshal and Olsson (1971), Mikić et al., (1987), and Thorson et al. (1989).



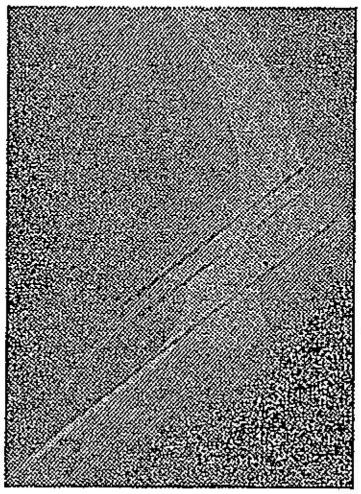


Figure 3. Lateral projection (fig. 3a) and stress image of the same knee (fig. 3b) in the group where ACL was replaced by a fascia lata autograft, show mild anterior translation of the tibia under the anterior drawer test.

After inflicting an artificial lesion to the ACL in the first group, reconstruction was attempted using the technique of Patsama Somethat modified (Newton i Nunmaker 1985). It is similar to Hey Groves technique in human orthopaedic surgery, which was introduced in 1916. and replaced the ACL by an autograft of fascia lata (Groves 1985). On the other hand, in the era of artificial materials, carbon fibers are increasingly being used. Carbon fibers are strong but brittle and have been reported to be highy compatible, although very different clinical results have been reported (Jenkins 1985, Lemaire 1985, Mendes, et al. 1985. Parsons, et al. 1985,). In addition to clinical results, radiological findings are used as basic and reliable indices of the status of genicular solid structures after various procedures (Funk, 1983, Fairclough et al. 1990.) The degree of laxity and consequent instability of the knee can be directly evidenced radiographically (Popović 1983).

CONCLUSION

X-ray examinations did not reveal differences between the two groups of on animals operated. No significant arthrotic changes were noted, i. e. the knees remained unaffected in both groups of experimental animals.

The drawer sign was performed manually and measured on the X-ray profile during stress. It was less in the carbon fiber group (mean 8.16mm), than in the group where ACL was replaced by fascia lata (11.5mm). However, the extent of anterior translation in group B (fascia lata) decreased with time, while it remained the same in the carbon group. We cannot advocate the use of one type of graft since the X-ray findings were similar in both cases.

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RADIOLOŠKA SLIKA KOLENA POSLE REKONSTRUKCIJE PREDNJEG UKRŠTENOG LIGAMENTA PSA

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SADRŽAJ

Autori su ispitivali radiološku sliku kolena psa posle rekonstrukcije prednjeg ukrštenog ligamenta karbonskim vlaknima ili fascijom latom, modifikovanom Patsaminom tehnikom i intraartikularnim plasiranjem karbonske proteze. Klinička slika je procenjivana posle 1, 2, 4 i više meseci. Autori nisu našli značajnije degenerativne promene i tunel u kosti nije bio zamenjen tkivom kosti. Ovim eksperimentom, sa radiološke tačke gledišta autori nisu mogli da potvrde superiornost proteze od karbonskih vlakana u odnosu na tkivo autografta kao substituenta za prednji ukršteni ligament kod eksperimentalnog modela psa.