

**RADIOLOGICAL EXAMINATION OF THE SANATION OF FRACTURES OF THE
MEDIAL AND LATERAL MALEOLUS OF DOGS TREATED BY RIGID
AND NON RIGID FIXATION METHODS**

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Fractures of the medial and lateral maleolus of the ankle were artificially provoked in 10 dogs. Osteosynthesis of the fracture was made in 8 dogs, by applying rigid and non-rigid methods of fixation. Two dogs were conservatively treated, without osteosynthesis. The radiological parameters of the sanitation of the fracture were compared with the clinical state of the joints.

INTRODUCTION

In human as well as in veterinary orthopedics fractures of the distal part of the lower leg, ankle (art. talocrurali) are very frequent (Kelikian, and Kelikian 1985, Burnwell and Charnley 1965). Such fractures most often occur as a consequence of accidents, but also from other types of trauma. Fractures of the ankle are treated in different manners, from non-operative, through operative nonrigid methods (Cedel, 1967, Figure 1), to operative rigid fixation methods established in the 70s by authors from the AO Fractures of the ankle treated in different manners, from non-operative, through operative nonrigid methods (Cedel, 1967, Figure 1), to operative rigid fixation methods established in the 70s by authors from the AO school (Rockwood, and Green 1984). There are difference among the data in the literature (Cedel 1985, Malka, 1969, Ollerud and Molander 1986, Ovadia 1986), concerning the results obtained in practice regarding the value of these two basic methods of fixation, as well as concerning the importance of fixation of both segments of the ankle, medial and lateral (Yablon et al., 1983, Bauer et al., 1985, Burnwell and Charnley 1965, Bonin 1950). Therefore we set up an experimental model for the canine ankle and monitored radiologically and clinically the sanitation of an artificially caused fracture treated in conservative and operative maners by the application of rigid and nonrigid fixation methods..



Figure 1. Rendgenograms of the fractured tarsal joints in dog 1a: conservatively treated fracture

MATERIAL AND METHODS

A series of 10 homogenous, male, skeletally sound dogs of mixed breed, aged 15 to 19 months and 17—19 kg. body weight were used. Prior to their inclusion in the experiment, clinical examinations, laboratory blood test and radiological checks of the ankle were carried out for all then dogs. The dogs were inoculated with SHL-P vaccine and treated with antihelmintics. During the experiment they were fed granulated food for dogs and powdered milk.

The pre-operative preparation of the animals involved a 24 hour fast prior to the operation, application of antibiotics (LONGACEF 1G), anesthesia (Combelen 0.3 ml/kg i.v. and Ketalar 50 mg/ml in doses of 0.3 ml/kg i.m.) as well as the preparation of the operation area.

The intervention was performed by making an incision in the skin above the maleolus and by artificially provoking fracture of the maleolus with a chisel according to *Lambote (1938) and Lane, 1905*, 1.5 cm approximately from the articular surface (Figure 2). Fragments were fixed by applying rigid and nonrigid osteosyntheses, i.e. by building-in a screw or two Kirschner (K) pins in to the medial segment and staples or one K-pin into the lateral segment (Figures 3a, b). The osteosynthetic material was taken out six weeks after the operation. Post-operatively, the animals were checked clinically and laboratory controls of their health were made until sacrifice. The state of the operated joints was observed by examining the degree of laming, assessed according to *Kester 1950* with grades from I to IV.

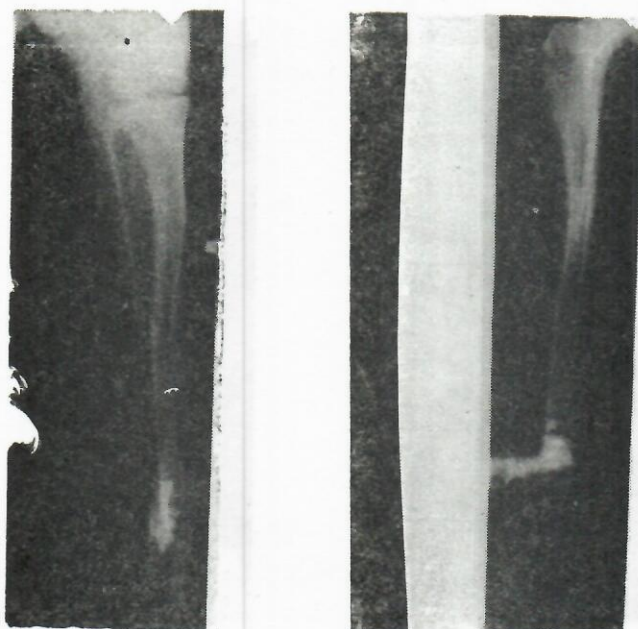


Figure 2a, b. Rendgenograms of the artificially provoked maleolar fracture

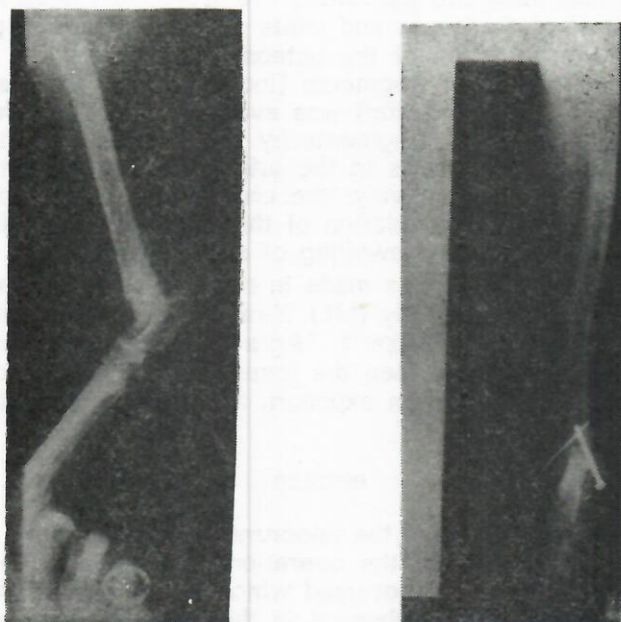


Figure 3a. Rendgenograms of the fractured maleolar bone after rigid fixation



Figure 3b. Rendgenograms of the fractured maleolar bone after non-rigid fixation

Radiographic examinations of the ankles of these dogs were made before, during and after the operation. Pre-operative radiographic examination of the state of the bones and joints of the talocrural region allowed evaluation and the selection of the osteosynthetic materials to be used. Intraoperatively the ratio of fragments (localization of the fracture direction of the line of discontinuation) was evaluated including the aspect of edges, size and position of fragments by the fixation material. The success of the return of fragments to the original position upon reconstruction was assessed postoperatively: the creation of callus (speed, quality and aplanation); state of articulation of the talocrural joint, interarticular space, sclerosis of edges and swelling of soft tissues.

The X-ray examination was made in two basic projections: anteroposteriorly (AP) and mediolaterally (ML). X-ray pictures were taken using a standard RTG apparatus ("Philips"). "Agfa Gevaert" films of 24 x 30 cm were used. The distance between the focus and the film amounted to 50 cm by using the stop 07 and an exposure time of 0.06 seconds, X-rays of 50 Kv and 20 mA.

RESULTS

Normal macrostructure of the talocrural joints was found on the X-ray diagrams of all dogs prior to the operation. In 4 dogs (2, 8, 9 and 10) all centres of ossification were not used which indicated that the growth of bones was not complete, but changes in the macrostructure of the bones (Figure 4) did not occur even in these dogs.

On the intraoperative X-ray diagrams it was seen that the lines of discontinuation on the medial maleolus were slanted, tooted and dislo-

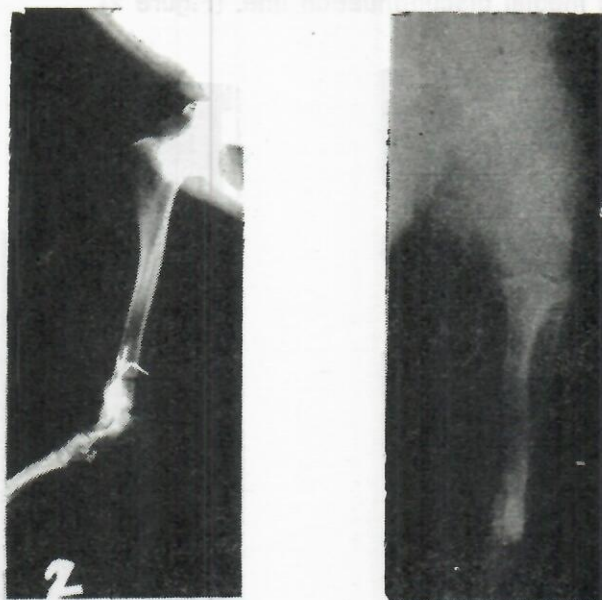


Figure 4. Rendgenograms of the tarsal joints prior to the operation



Figure 5. Rendgenograms of the fixed tarsal joint with a misplaced screw

cated in the majority of dogs. On the lateral maleolus the discontinuation line with a minimal dislocation was at 0.6—1.0 cm above the line with respect to the medial discontinuation line. (Figure 2)

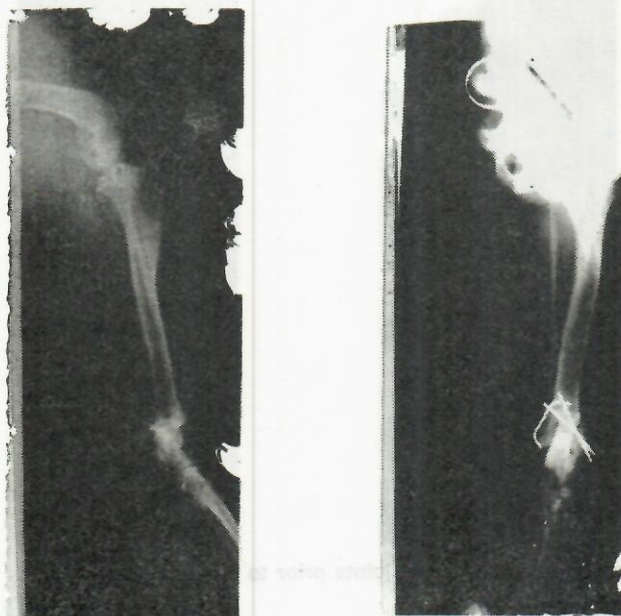


Figure 6. Rendgenograms of the insufficiently tight fixation of the maleolus with a migrating clump

X-ray diagrams were made one, 21 and 31 days after the operation. After application of the rigid method of fixation of the medial maleolus by means of a screw in 4 dogs (1,4,5, and 8), the direction of the propagation of the screw from the medial to the central part of the epimeta-physis of the tibia was observed. In one dog (no 1) the screw head was lying in the fractural gap at a distance of 1.5 mm from the joint surface, which represented an error in fixation Figure 5.). In the other dogs (4, 5 and 8) the screw heads were correctly positioned centrally on the top of the maleolus. When fixing the lateral maleolus by the K-pins it was found that the needles propagated in to the bone to the length of 2.3—3 cm, with a part (1.3—1.5 mm) in the soft tissues.

After the application of the nonrigid fixation method of the medial maleolus with two K-needles, it was observed from the X-ray diagrams of the ankles of 4 dogs (2, 3, 6 and 7) that the needles were placed in parallel to a length of about 3.5 cm with penetration into the soft tissues of 2 mm (dog 7), 4 mm (dog 6) and 6 mm (dog 2). Osteosynthesis of the lateral maleolus by a staple was executed correctly in all dogs, except in dog no. 2 where the lower part of the clump protruded into the joint as a consequ-

ence of an insufficiently tight fixation and and a consequent migration of the clump (Figure 6).

On the X-ray diagrams of the ankle bones 31 days (Figure 6), after the operation, minimal reduction of the intraarticular space was observed in 3 out of 10 dogs, while in the dog (no. 8) to which rigid osteosynthesis was applied, considerable reduction of the space with sclerosis of the joint edges was prominent. Around the migration pins a swelling of the soft tissues was noticed (Figure 7). The macrostructure of the crural bones was not changed in any dog, the callus was in a good or excellent state of consolidation with all three methods of treatment applied.

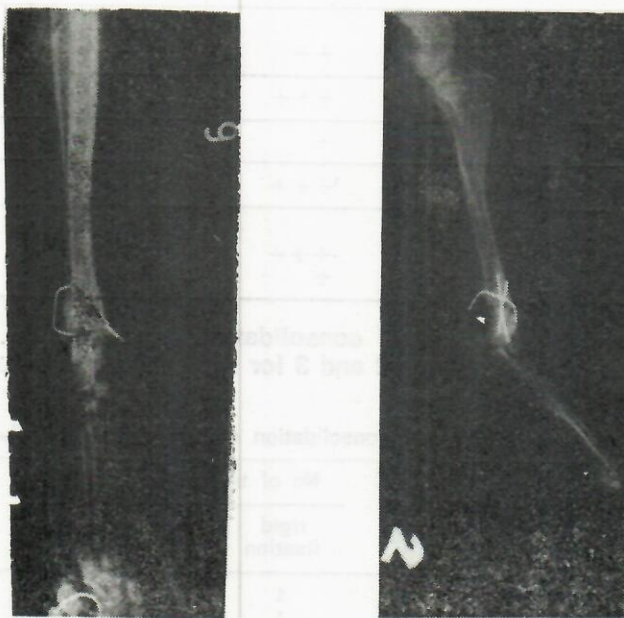


Figure 7. Rendgenograms of the fixed tarsal joint with a swelling of the surrounding soft tissues

The degree of radiological consolidation (the size and quality of the callus) on the medial and lateral maleolus and the functional state of the ankle 21 days after the operation depended on the method of treatment applied (table 1).

Table 1. The degree of radiological consolidation of the tarsal joint fracture in dogs

Dog no	Treatment methods	Degree of radiological consolidation		Degree of laming
		Medial maleolus	Lateral maleolus	
1	Rigid fixation	+	+++	I
4	„	+++	+++	IV
5	„	++	++	IV
8	Nonrigid fixation	+++	+++	I
2	Nonrigid fixation	++	+	I
3	„	+++	+++	0
6	„	+	+	I
7	„	+++	+++	I
9	Conservative treatment	+++	+	I
10	„	+	+	0

The degree of radiological consolidation depending on the methods of treatment is given in tables 2 and 3 for the medial maleolus and lateral maleolus respectively.

Table 2. The degree of radiological consolidation of the medial maleolus

Medial Maleolus Degree of Radiological Consolidation	No of treated dogs with		Conservative
	rigid fixation	nonrigid fixation	
+	1	1	1
++	1	1	—
+++	2	2	1
Total	4	4	2

Table 3. The degree of radiological consolidation of the lateral maleolus

Lateral Maleolus Degree of Radiological Consolidation	No of treated dogs		Conservative
	rigid fixation	nonrigid fixation	
+	—	1	1
++	1	1	—
+++	3	2	1
Total	4	4	2

DISCUSSION

After the osteotomy which simulated a traumatic fracture of the ankle in the experimental dogs, the operative intervention was carried out in accordance with all regulations for antisepsis applied in veterinary practice. The selection of osteosynthetic material was made analogously with rigid and nonrigid fixations in human orthopedics with an adjustment to the size and the shape of the ankle of a dog (Newton and Nunmaker, 1985). For fixation of the medial and lateral maleolus a screw and K. needle were applied in dogs no. 1, 4, 5, and 8, and the modified Cedel fixation method with a staple and 2 needles in dogs no. 2, 3, 6, and 7. All the animals underwent the surgery well.

The degree of lameness (as an objective parameter) was correlated with the radiographic assessment of the success of osteosynthesis, not with the type of osteosynthesis. The dogs with osteosynthesis material in the joint (dogs 1 and 2) manifested the same degree of lameness (degree IV) irrespective of time and joint damage, because the lameness remained even after taking out the osteosynthetic material. In all other cases, even if residual lameness existed initially, it disappeared upon removing the osteosynthetic material. It was particular pronounced after the application of K-needles which were seen on the X-ray diagram to migrate, penetrating into soft tissues and provoking reactive swelling (dog no. 6).

The 10-dog series is too small for interring definite conclusions, but the radiographic investigations unambiguously show that the time needed for the creation of callus (3—4 weeks) was correlated with the clinical findings and errors in osteosynthesis. It was also seen that in dog no. 1 the ankle's function was not damaged, although coalescence of the fracture of the medial maleolus did not occur. This confirms the findings of some human orthopedists about the minor significance of the medial maleolus of the ankle with respect to the lateral segment (Lindsjo, 1985, Yablon et al., 1983), while other authors (Bonin, 1950, Burnwell and Charnley, 1965, Danham 1964) had the opposite opinion which we failed to confirm. However, even weakly pronounced callus in nonrigid fixation of the lateral maleolus by a staple can result in good functional state of the ankle, on condition that the material is not in the joint. (dog 6). Excellent clinical and radiological results were attained if the needles were sufficiently long and if the staple did not enter into the joint, i.e. if the osteosynthetic material is correctly built-in (dog 3). — In dog no. 1 with the screw in the joint, the lameness remained, but not as a consequence of noncoalescence of the fracture of the medial maleolus but due to irritation of the joint (panus and degenerative alterations). All these indicate that correct positioning of the outcome, because when osteosynthesis was error-free, on the 31th day callus was already well pronounced. Moreover, on the 45th day and the 60th day the place of the fracture could not be found by macroscopic examination of the amputated leg.

The narrowing of the talocrural space appearing in one case of nonrigid fixation and in two cases of rigid fixation was minimal. Osteoporosis occurred in dogs 2 and 4 where both fixation methods were applied. By

following the clinical state of the ankle it was found that the radiological picture of the nonpronounced callus provides a lameness degree from 1 to 0.

CONCLUSION

A very solid callus was made after applying a screw for fixing the medial segment and staples for fixing of the lateral segment of the ankle. An excellent clinical and radiological result was obtained with properly built-in osteosynthetic material. The degree of limping (as an objective parameter) was correlated with the radiological finding of successful osteosynthesis, but not with the kind of osteosynthesis. Incomplete sanation of the medial maleolus did not affect the function, but in the presence of osteosynthetic material in the joint the limping was salient, as well as radiological changes in the ankle bones. In conservative treatment a minor dislocation of bone fragments occurred, but the callus was solid.

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**RADIOLOŠKA SLIKA SANACIJE PRELOMA UNUTRAŠNJEG I SPOLJAŠNJEG
MALEOLUSA PASA LEČENIH METODAMA RIGIDNE I NERIGIDNE FIKSACIJE**

A. LEŠIĆ, ANICA ZAGORČIĆ, J. VASIĆ, I N. KRSTIĆ

SADRŽAJ

Kod 8 pasa izvršena je osteosinteza arteficialno izazvanih preloma lateralnog i medijalnog maleolusa primenom rigidne i nerigidne fiksacije. Dva psa lečena su konzervativno, bez primene osteosinteze. Radiološki parametri sanacije preloma poređeni su sa kliničkim stanjem zglobova.

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Figure 3b. Rendgenograms of the fractured maleolar bone after non-rigid fixation

Radiographic examinations of the ankles of these dogs were made before, during and after the operation. Pre-operative radiographic examination of the state of the bones and joints of the talocrural region allowed evaluation and the selection of the osteosynthetic materials to be used. Intraoperatively the ratio of fragments (localization of the fracture direction of the line of discontinuation) was evaluated including the aspect of edges, size and position of fragments by the fixation material. The success of the return of fragments to the original position upon reconstruction was assessed postoperatively: the creation of callus (speed, quality and aplanation); state of articulation of the talocrural joint, interarticular space, sclerosis of edges and swelling of soft tissues.

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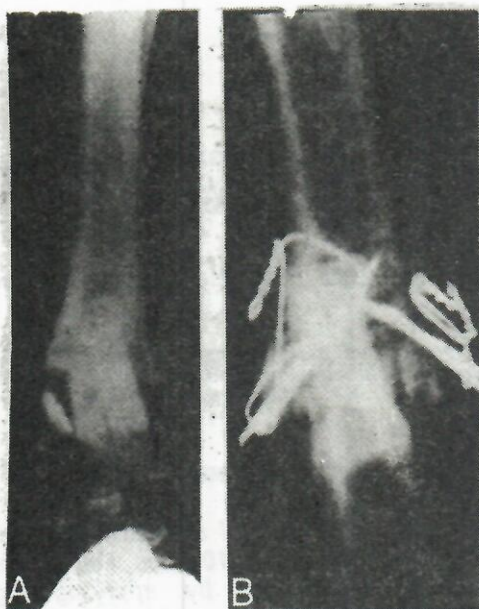


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