

Pancarpal and pantarsal arthrodesis applications using compression plates in dogs

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ABSTRACT: Pancarpal arthrodesis was carried out in 6 dogs and pantarsal arthrodesis in 3 dogs, which could not use their extremities due to various reasons. For arthrodesis, 3 and 4 mm thick compression plates were used. The application was done on the dorsal aspect. Fusion was radiographically seen to have formed between post-operative 45–75 days in 10 joints belonging to 9 cases. The plate broke in one case. With the exception of 1 case, functional recovery was achieved in all cases accompanied with varying degrees of lameness. While the material was removed from 1 case in which the plate broke and another in which a chronic wound developed in the operation site, plates were not removed from any of the other cases.

Keywords: carpus; tarsus; joint; arthrodesis; dog

Pancarpal arthrodesis includes the fusion of the antebrachial, middle carpal and carpometocarpal joints, while pantarsal arthrodesis is the fusion of the tibiotarsal, proximal and distal intertarsal and tarsometatarsal joints. Indications for pancarpal and pantarsal arthrodesis can be listed as; shearing injuries, osteoarthritis, standing deformities due to nerve paralysis, painful and unstable conditions unresponsive to reconstruction, incurable tendon and ligament injuries and multiple fractures (Brinker *et al.*, 1998).

Plate application is the most frequently used method in pancarpal and pantarsal arthrodesis. In pancarpal plate applications, a curve of 10–12 degrees is given to the plate and application is done on the palmar surface of the carpus. In pantarsal application, the plate is applied to the cranial surface of the distal *tibia*, *tarsus* and *metatarsus* with an angle of 135–145 degrees (DeCamp *et al.*, 1993).

Rongeur, osteotomes, curettes and drills may be used to destroy the joints. Ankylosis will develop unless a sufficient amount of subchondral bone cannot be exposed. Cancellous bone grafts must be applied to the joint space in order to increase healing of the bone (Johnson, 1980).

Selection of the plate to be used for arthrodesis is important. If the plate is too small it may break, if it is too large it will cause structural weakening of the bone (Johnson, 1980).

For the purpose of pancarpal and pantarsal arthrodesis, external fixation may be applied, particularly in cases of shearing injuries. There will be less soft tissue damage with this application (Trostel and Radasch, 1998; Benson and Boudrieau, 2002).

This study was carried out to provide function to the extremity that had lost its function due to reasons such as; chronic joint luxations, nerve paralysis, tendon shearing etc, by carrying out pancarpal and pantarsal arthrodesis applications instead of amputation.

MATERIAL AND METHODS

The material of the study consisted of 9 dogs brought to the Small Animal Surgery Clinic between the years of 1996–2002.

Firstly, clinical examination of the patients was carried out and a detailed history was obtained from the patient owners and treatment options

were investigated. According to whether the lesion was in the front or in the back leg, medio-lateral and anterior-posterior radiographs were taken of the carpal or tarsal joints. In cases where it was decided that there was no other treatment, pancarpal or pantarsal arthrodesis was selected. In one case, a previously unsuccessful pancarpal arthrodesis, done in another practice, was repeated.

For pancarpal arthrodesis, after carrying out general surgical rules, a cranial (dorsal) skin incision of approximately 10 cm was made starting from the distal antebrachium until the distal metacarpus. Following subcutaneous tissue dissection, cephalic and accessory cephalic veins were moved to one side and removed from the site. *Musculus extensor carpi radialis* was cut and the intercarpal and carpometacarpal joints were reached. The abductor pollicis longus tendon was moved to one side using a retractor. After this, capsules and short ligaments of the radiocarpal, middle carpal and carpometacarpal joints were severed. An electric drill with 3.5 and 4.5 drills and curettes were used to destroy the joint cartilage. Cancellous bone grafts previously taken from the humeral region of the same leg were placed in the bone spaces. The 3 or 4mm-thick compression plate with a curve of approximately 10 degrees was adapted to the region and fixed with 3 cortical screws in the radius, 1 screw in the radial carpal bone and 2 or 3 screws in the third metacarpal bone. All tissues were ap-

propriately closed and the leg was supported with an aluminium splint bandage for 3–4 weeks.

Approach for pantarsal arthrodesis was similar to pancarpal arthrodesis, by making a skin incision starting from a point near the distal tibia in a cranial (dorsal) direction towards the distal metatarsi. Following dissection of the subcutaneous tissues, *musculus extensor digitalis longus* was moved to one side with a retractor, the short ligaments of the tarsocrural, mid-tarsal and tarsometatarsal joints were severed, the joint capsules were destroyed and bone grafts were placed. An angle of approximately 135–145 degrees was given to the compression plate to be used and 3 cortical screws were placed in the tibia, 1 in the talus and 2 in the metatarsus. An aluminium splint bandage support was provided for 3–4 weeks (Lesser, 1993).

Patients were given clinical and radiological check-ups twice in the post-operative first month and at one or two-month intervals thereafter. When necessary, information was obtained over the telephone. Following removal of the bandage in the post-operative period, the animals were allowed lead exercise.

RESULTS

In 9 dogs brought to our clinic in the 6-year period between 1996–2002, pancarpal arthrodesis

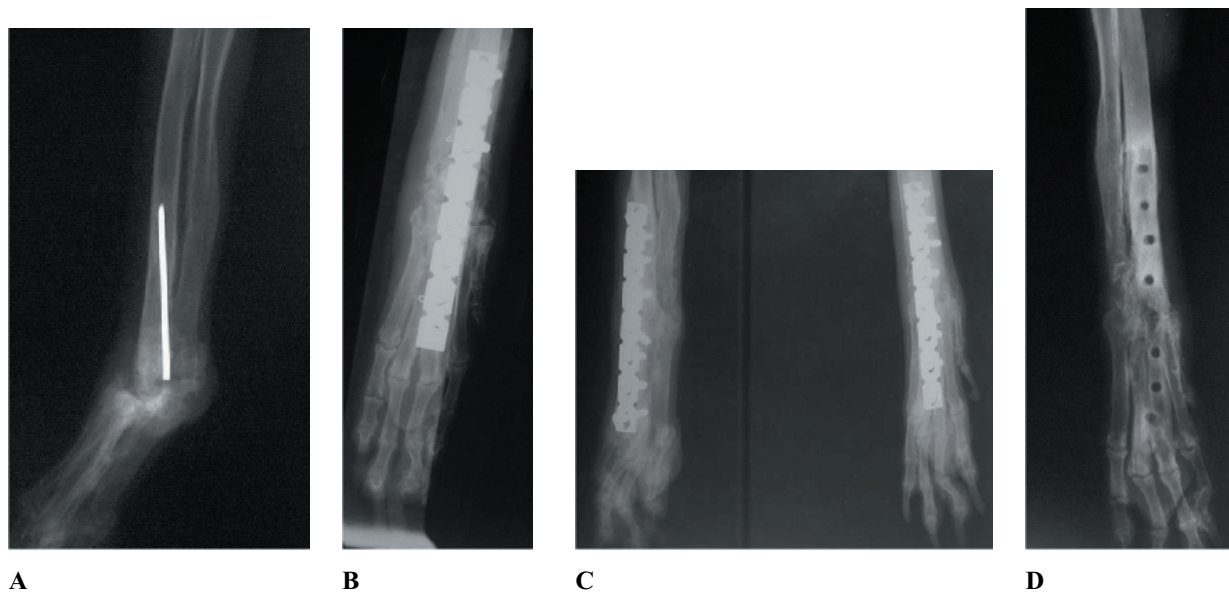


Figure 1. A – Pre-operative appearance of the case no 1, which had been previously operated on in another practice and non-union had occurred. B – Anterio-posterior radiographic view immediately after surgery. C – Radiographical appearance postoperative day 75. D – Radiographical appearance after removal of the plate

Table 1. Evaluation of the cases which underwent pancarpal and pantarsal arthrodesis

| Case No. | Breed | Age (year) | Gender | Weight (kg) | Reason for arthrodesis | Plate and screw size | Complication | Clinical outcome |
|----------|--------------------|------------|--------|-------------|-------------------------------|-------------------------------|-------------------------------|------------------------------------|
| 1 | Collie | 10 | male | 22 | carpal luxation | plate 4 mm, screws 3.5 mm | muscle atrophy | no lameness |
| 2 | Cross-breed | 1 | male | 25 | quadriceps muscle contracture | plate 4 mm, screws 3.5 mm | muscle atrophy | slight lameness |
| 3 | Anatolian Shepherd | 1.5 | male | 25 | bilateral carpal subluxation | plate 4 mm, screws 3.5–4.5 mm | screw loosening | no lameness |
| 4 | Anatolian Shepherd | 1 | male | 30 | carpal subluxation | plate 4 mm, screws 3.5 mm | – | intermittent mild lameness |
| 5 | Collie | 1 | male | 21 | carpal subluxation | plate 3 mm, screws 2.7–3.5 mm | muscle atrophy | no lameness |
| 6 | Cross-breed | 1 | male | 24 | carpal subluxation | plate 4 mm, screws 3.5 mm | – | no lameness |
| 7 | Cross-breed | 5 | male | 35 | tarsal luxation | plate 4 mm, screws 3.5–4.5 mm | – | slight lameness |
| 8 | Collie | 2 | male | 23 | sciatic nerve paralysis | plate 3 mm, screws 3.5 mm | plate failure, muscle atrophy | step on the dorsal face of the paw |
| 9 | Collie | 3 | male | 21 | carpal subluxation | plate 3 mm, screws 2.7–3.5 mm | screw loosening | no lameness |

was carried out in 6 dogs and pantarsal arthrodesis in 3. Arthrodesis was carried out in both carpal joints in 1 case. These dogs belonged to different breeds. Age distribution ranged between 1–10 years. Bodyweight of the patients changed between 21–35 kg. The procedure was repeated in one case, which had already undergone arthrodesis carried out in another practice but where fusion had not occurred due to non-union (Figure 1). The reason for arthrodesis in the other 8 cases were: deformation and carpal subluxation related to growth disorders in 3, abnormal stance due to ischiadic paralysis in 1, hyperextension in the tarsal joint due to quadriceps muscle contracture caused by soft tissue injury in 1, cranial luxation of the tarsal joint and multiple fracture in 1 and chronic antebrachio-carpal subluxation due to palmar carpal ligament rupture in 2 cases (Table 1).

In one case of pantarsal arthrodesis, the plate broke at the curved point on post-operative day 60 and was subsequently removed. At this time no further surgical intervention was done as it was radiographically established that fusion had occurred and that the patient was using the leg at the desired tarsal joint angle. In one other pancarpal arthrodesis

case, due to the presence of a non-healing wound over the plate, following radiological confirmation that fusion had taken place, the plate was removed on post-operative day 75 and no problems were encountered. The remaining 8 compression plates used in the other 7 cases were not removed. In 2 of these cases, loosening occurred in one screw in each case, however these were not removed, as they did not affect stability.

Fusion was radiographically established to have occurred between days 45–75 in all arthrodesis procedures in the 10 joints belonging to 9 cases. The desired form was achieved in the tarsal joint in the application carried out to correct the abnormal stance due to ischiadic paralysis caused by faulty intramuscular injection. However, due to insufficiency of proprioception, the patient continued to step on the dorsal face of the paw. Because of this, the desired functional success could not be achieved. The deformity in the extremity was corrected and functional position was achieved in the other cases.

With the exception of one case, in which fusion had taken place, extremity movements of patients, which had undergone arthrodesis, were function-

ally evaluated. Before and after the operation, distinctive muscle atrophy was observed in 4 cases, in the related extremity due to the leg not being used for a longer period compared to the other cases. Lameness continued slightly in 2 cases and intermittent mildly in 1 case.

DISCUSSION

Pancarpal or pantarsal arthrodesis applications can be carried out with plates positioned on the lateral, dorsal and plantar aspects, intramedullary pins, lag screw and external fixation applications. A more stable fixation may be achieved when compression plates are used for this procedure. Particularly in pantarsal arthrodesis, although the dorsal aspect does not stretch, due to the high bending forces it endures, the plate may break at the point of bending (DeCamp *et al.*, 1993). Low success in arthrodesis is related to inadequacy in providing fusion. Reasons for this are; inappropriate implants, loosening and breaking (Gorse *et al.*, 1991). In this study, the plate in a pantarsal arthrodesis case had broken on post-operative day 60 and it was seen that the patient, which had until then used its extremity to a great extent, felt pain and did not use the leg at all following breaking of the plate. The plate was seen to have broken at the sharpest point of the curve, which was thought to have taken place with relation to the excessive movement occurring due to a decrease in plate resistance and the patient using the leg without limitations. In 2 cases, screw loosening was determined in 1 screw applied to the third metacarpal in each case. However, the screws were not removed as this did not affect plate stability. This may be because the bones did not grasp the screws sufficiently enough or that the dimensions of the screws used were not appropriate.

External coaptation must be continued for 1.5 to 6 months after arthrodesis applications (Trostel and Radasch, 1998; Wilke *et al.*, 2000). Johnson (1980) has recommended that, splints should be continued for at least 6–10 weeks. In our study, an aluminium supported bandage was used for 3–4 weeks, followed by a bandage with thick cotton padding for 2 weeks. While duration of our bandages was shorter than other studies, with the exception of the plate breaking in one case, no other complication was encountered with possible relation to the length of this duration. Continuing external fixation for a long time may cause muscle atrophy,

pressure necrosis and stiffening in the other joints (Johnson, 1980). While muscle atrophy occurs in some cases, we think that, this is related to both the extremity being kept in a bandage and also it not being used.

Especially when using narrow lengthening plates in pantarsal arthrodesis procedures in large dogs, the risk of breaking may drop to the lowest level due to the central part of the plate having no screws (DeCamp *et al.*, 1993). Smith and Spognola (1991) have recommended using a T-plate for partial and pancarpal arthrodesis. Dimensions of the plate and screws to be applied to the metatarsal or metacarpal regions in arthrodesis applications play an important role in the screw-holding strength of the bone and in closure of the surgical wound in this region. To reduce these risks, 2–2.7 mm and 2.7–3.5 mm hybrid plates may be used (Fettig *et al.*, 2002). Plate application to only the third metacarpal and metatarsal bones may cause stress and bone fractures (Johnson, 1980). Compression plates were used in this study. While varying according to the size of the animal, 2.7 mm and 3.5 mm screws were applied to the third metacarpal and metatarsal bones. In agreement with Fettig *et al.* (2002), hybrid plate application is a sensible procedure due to the weakness in bone-screw holding strength. However, because these plates could not be obtained commercially, they could not be applied. In this study, several difficulties were encountered in screw applications to the mentioned bones. Locating the centre of the bones and providing sufficient screw holding strength was reasonably difficult. For this reason, while applying screw to the distal part, screws with a smaller diameter than those used in the proximal part bones should be used. Although the diameters of the screw used in the distal and proximal parts were equal, no fractures were encountered in these bones.

Reasons for unsuccessful results in cases of arthrodesis may be due to the degenerative joint diseases developing because of the changing biomechanical stress in the joints proximal to the arthrodesis region and the fractures in the arthrodesis site (Gorse *et al.*, 1991). In 2 different studies it has been reported that, fusion was achieved in the arthrodesis site in 9 patients out of 11 in one study (DeCamp *et al.*, 1993) and that the successful functional result was 25% in the other study (Gorse *et al.*, 1991). As also seen in this study, radiological achievement of fusion is not sufficient enough to produce clinical function. In all our cases, although

fusion had occurred radiographically and there was no clinical problem, a slight lameness persisted in some of the cases.

As a result, the mentioned orthopaedic disorders that cannot be cured using other methods can be treated successfully with pancarpal and pantarsal arthrodesis applications, which as well as relieving the pain in the area, will save the leg from being amputated and to a great extent return it close to normal extremity function. It was also concluded that, plate applications done on the dorsal aspect provided easier approach and stability compared to other areas and that cancellous grafts and external support used after surgery increased healing and stability.

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