Arthrodesis Masterclass for Advanced Practitioners Mini Series

Session Two: Arthrodesis of the hock

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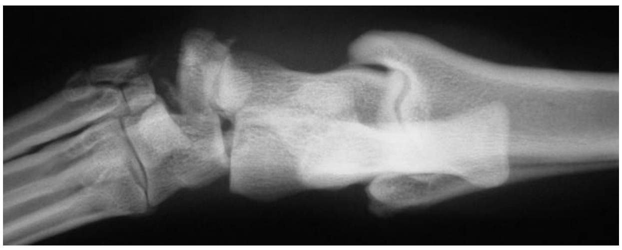

Arthrodesis of the hock

The hock is composed of a number of different joints of which the talocrural joint has the greatest range of movement, functioning as a hinge with motion in one plane (flexion and extension). While its anatomical conformation provides some inherent stability, collateral support is provided by the medial and lateral collateral ligaments, which originate on the medial or lateral malleoli. In the cat the caudal tibial and short peroneal muscle tendon units act as contractile tension bands across the talocrural joint increasing its stability. During the stance phase the talocrural joint is held in approximately 125-135° or 115-125° of extension in dogs and cats respectively by the Achilles mechanism which inserts onto the calcaneus. The talocrural joint and the Achilles mechanism can be affected by a variety of abnormalities. These include developmental, traumatic, degenerative, neurological and inflammatory conditions, which can have a profound impact on limb function and for which medical management, or a straightforward surgical solution may not be possible or effective. In such situations, arthrodesis of the talocrural joint may allow limb function to be restored.

The intertarsal and tarsometatarsal regions are a complex composite of low motion joints supported by a myriad of different ligamentous structures. Joint stability and thus distal limb posture, is maintained by a strong plantar ligament complex on the tension aspect, whilst dorsally on the compression aspect, the requirement for such robust ligament support is unnecessary. A variety of ligaments provide both lateral and medial intertarsal stability. Instability can originate at different joint levels; common locations include the proximal intertarsal joint, centrodistal joint or tarsometatarsal joints. From a diagnostic perspective the two most important factors are to determine are the joint(s) at which the instability is originating and what supporting ligamentous structures are damaged; both dictate what management will be required. Thorough clinical and radiographic assessment (the latter may require stressed projections) is paramount to obtain both an accurate diagnosis and to allow appropriate decision-making. In many situations, inter tarsal or tarsometatarsal arthrodesis may allow limb function to be restored.

Arthrodesis, like joint replacement and excision arthroplasty is a salvage surgical procedure which aims to restore limb function when other treatment options for doing so are considered suboptimal. However in contrast to joint replacement or excision arthroplasty, arthrodesis restores function through abolishing movement of the joint by osseous fusion. Irrespective of the fixation system used to stabilise the talocrural joint, the principles of arthrodesis should be adhered to, in particular meticulous articular cartilage debridement, use of bone grafting and achieving a functional joint position (arthrodesis angle).

Talocrural arthrodesis

Historically talocrural arthrodesis was performed in isolation using various combinations of pins, lag screws +/- orthopaedic wire and bone plates (Piermattei and Flo 1997) supplemented with external coaptation. The mechanical challenge placed on such fixation systems resulted in a high risk of complications (Klause and others 1989) such as implant failure, failure to achieve arthrodesis and the development of inter-tarsal or tarsometatarsal degenerative joint disease. In order to improve upon this poor mechanical situation, pantarsal arthrodesis (PTA) (arthrodesis of the talocrural, inter-tarsal and tarsometatarsal joints) was considered more appropriate. It was proposed that spanning the entire tarsus with incorporation of the distal tibia and metatarsus would allow more mechanically robust internal fixation to be used and avoid mechanical overload of the inter-tarsal and tarsometatarsal joints. Initially PTA was performed using a lengthening or dynamic compression plate and screws applied to the dorsal aspect of the tarsus (Gorse and others 1991, DeCamp and others 1993). As with pancarpal arthrodesis, dorsal plate constructs are applied to the compression aspect of the joint and are particularly susceptible to failure through cyclical loading (manifested and implant loosening or plate breakage). Such complications can prevent successful arthrodesis. The likely hood of dorsal construct failure is further increased due to the arthrodesis angle required coupled with the long lever arms on both the tibial and metatarsal sides of the construct. Biomechanics are further compromised by the plate being secured distally to the 3rd metatarsal bone. This single bone is subjected to all the axial loads placed through the bone-implant construct as well as dictating the size of implant which can be used and thus the mechanical strength of the construct. Application of a plate to the plantar aspect of the hock would overcome some of the biomechanical inadequacies by being placed on the tension aspect of the joint. Although this technique has been performed (McCartney 2010*)* its use has never gained popularity, most likely due to the complexity in the surgical approach (Klause and others 1989).

As with selective talocrural arthrodesis, external coaptation has been considered necessary in the immediate postoperative period following PTA to provide additional support. External coaptation is not without the potential for minor or major complications, requiring meticulous management and a further financial commitment from the client. Morbidity associated with external coaptation following either partial tarsal (inter-tarsal and/or tarsometatarsal) arthrodesis or PTA has been reported in 40% (Roch and others 2008) and 56% (Meeson and others 2011) of dogs. Meeson and others (2011) also reported that the financial cost to the client of treating the resultant soft tissue injuries associated with cast application to the distal limb ranged from 4-121% of the original orthopaedic procedure. As with pancarpal arthrodesis the use of adjunctive external coaptation following either partial tarsal arthrodesis or PTA has become an area of increasing debate.

Advances in plate fixation for PTA has primarily occurred through innovative plate design, resulting in a more appropriate selection of implants to accommodate for a wide range of patient sizes. PTA plate design and application has predominately focussed on optimising the mechanics of the bone-implant construct. In doing so it is hoped that the frequency of postoperative complications such as screw loosening or plate failure (Gorse and others 1991, DeCamp and others 1993) will be reduced.

With improved mechanical stability, perhaps the perceived requirement for adjunctive external coaptation will be negated?

Plate design has largely focussed on the development of an implant for medial application to the distal limb, allowing for 'edge' loading of the bone plate, which optimises its bending strength. This coupled with screw engagement of multiple metatarsal bones distally due to their mediolateral orientation offers a mechanical advantage in comparison to dorsal plating and has been demonstrated by Guillou and others (2008). McKee and others (2004) described use of a custom made bone plate for application to either the medial (12) or lateral aspect (1) of the talocrural joint. All constructs had adjunctive external support - cranial splint (12), ESF (1). A good to excellent outcome was achieved in 12/13 of the patients. The median arthrodesis angle was 135°. Plate failure occurred in 2/13 procedures and screw loosening in 1/13. Placement of a calcaneotibial positional screw (CTS) was recommended to increase mechanical stability and protect against plate failure. A good to excellent outcome was reported in 12/13 patients.

Following McKee and others (2004), an "off the shelf" 140° 3.5/2.7mm hybrid PTA plate for medial application was developed by Veterinary Instrumentation, which in turn has been followed by a small 3.5/2.7mm, 2.7/2.0mm and a feline 120° 2.7/2.0(1.5)mm hybrid PTA plates. Plates are side (i.e. left or right) specific. Like the hybrid dynamic compression plate (HDCP) used for pancarpal arthrodesis, it tapers in thickness and width distally facilitating skin closure and allowing for more appropriate (smaller) screw size placement in the metatarsus. Unlike the initial custom-made plates, the "off the shelf" plates did not have the plate hole for placement of a screw through the central tarsal bone into the fourth tarsal bone. This was due to the variability between patients in the location of this inter-tarsal plate hole. Many surgeons would modify the plate by adding this plate hole following preoperative radiographic templating. As a result Veterinary Instrumentation has recently produced new "off the shelf" plates with a slotted plate hole, which allows for accurate screw placement but accommodates for inter-patient variation. If for whatever reason the medial aspect of the distal limb cannot be plated then a hybrid PTA plate can be applied to the lateral aspect, following removal of the distal portion of the fibula. In this situation the opposite sided plate (i.e. left for right and *vice versa*) is used. Despite the wide selection of plates available custom-made implants may still be required for some patients.

Guillou and others (2008) have reported the development and mechanical testing of an alternative 3.5/2.7mm medial plate, which has a 140° degree bend, 5 tibial DCP holes, 2 talar round holes, 1 inter-tarsal DCP hole and 3 metatarsal DCP holes. The superior mechanics of this plate may remove the requirement for placement of the CTS. To these authors' knowledge this implant is not yet commercially available.

Medial plate application is the authors technique of choice when performing PTA. In the authors experience attention to detail during screw placement into the metatarsus is paramount. It should be remembered that the metatarsal arcade becomes orientated in a dorsally convex manner as it extends distally.

As a consequence engaging all four of the metatarsal bones is usually only possible proximally, with the most distal screws only engaging either one or two metatarsals. In the authors' experience, distortion of the metatarsal arcade through erroneous screw placement can be a cause of persistent lameness postoperatively. Although the authors' routinely place a CTS in dogs they do not do so in cats. Particular attention should also be given to achieving tension free skin closure, which can be challenging in the metatarsal region. If so a suitable tension relieving technique is required. When indicated the authors choice would be to create a single releasing incision on either the plantar or plantarolateral aspect of the metatarsus. Roch and others (2008) described the potentially limb threatening complication of plantar necrosis which they hypothesised to be a result of iatrogenic damage to the dorsal pedal or perforating metatarsal artery. It was reported to occur more frequently when a bone plate was applied to the medial aspect of the hock and only when the tarsometatarsal joint space was debrided of articular cartilage. Whilst such a direct iatrogenic vascular injury may be responsible the same problem could arise if skin closure is not tension free, which can result in a tourniquet effect and disruption of the vascular supply to the distal limb. The author do not routinely use external coaptation in the early postoperative period. A soft bandage is maintained for approximately 2-5 days postoperatively then discontinued. In the uncommon event of a releasing incision having been performed the period of bandaging will be extended until it has healed.

Dorsal plating is still preferred by some surgeons. The design features of the HDCP used for pancarpal arthrodesis have led to it use for PTA. Fitzpatrick & O'Riordan (2004) described the use of a dorsal 2.7/2mm HDCP for PTA in 11 cats. All cats regained achieved acceptable function. Tension free skin closure was reported as problematic in some patients, with plantar releasing incisions often being required. Although splinting or casting was not required, bandaging was necessary for a variable time as dictated by wound problems or skin closure techniques. Veterinary Instrumentation in conjunction with Noel Fitzpatrick have developed both feline and canine specific dorsal hybrid PTA plates, which come in a variety of sizes accommodating most patients. These plates are pre contoured providing an arthrodesis angle of 120°in cats and 140° in dogs. The bend of plates has been reinforced to strengthen this region reducing the potential for plate failure, whilst plate hole position and design allows for more accurate screw placement within the tarsus. More information on both the medial and dorsal hybrid PTA plates provided by Veterinary Instrumentation can be found at www.vetinst.com

The use of veterinary cuttable plates has also been reported in small dogs and cats (Theoret and Moens 2007). Cuttable plates can be stacked on top of each other to increase their bending strength, a technique which can be utilised to the surgeon's advantage in PTA.

Regardless of the implant system used, activity is restricted postoperatively until there is radiographic evidence of arthrodesis. The author generally recommend that follow-up radiographs are obtained after 6-10 weeks and every 4-6 weeks thereafter until arthrodesis is apparent.

Pantarsal arthrodesis offers a reliable and predictable salvage option for management of end stage talocrural disease and traumatic injuries that are not amenable to primary repair.

The procedure-specific implants now available allow for a predictable outcome and a good prognosis in the large majority of cases provided careful surgical technique and the principles of arthrodesis are followed.

Partial Tarsal arthrodesis

Partial tarsal arthrodesis is well tolerated, having no impact on either limb posture or function, given the inherent low motion nature of these joints. The requirement for partial tarsal arthrodesis is absolute when there is loss of plantar ligament support; the development of fibrous tissue to provide adequate plantar support, by some other means, should not be relied upon. Arthrodesis is this situation should be achieved with robust internal fixation using a bone plate and screws. When faced with inter-tarsal instability, but where plantar ligaments are intact, immobilisation of the affected intertarsal region, ideally with internal fixation but without cartilage removal, is likely to be sufficient i.e. fibroplasia is likely to provide adequate support; it is also assumed that intertarsal joints may achieve ankylosis. Limited articular cartilage debridement +/- bone grafting, are still appropriate to consider in these situations, and are performed by this author. The use of pins, screws and orthopaedic wire are often reported in these situations, however the use of an appropriate bone plate will provide more robust, reliable fixation whilst negating the requirement for any adjunctive external coaptation.

The proximal intertarsal joint (PITJ) consists of the calcaneoquartal, talocalcaneal joint and the talocentral joints. PITJ instability occurs in two distinct groups of dogs. It can occur secondary to a chronic degeneration of the plantar ligaments as seen most commonly in older Border collies / Shetland sheepdogs. Although lameness may not have preceded the apparent acute rupture, radiographs of these patients usually identify marked enthesiopathy of the planter ligaments. Such patients will often develop the same problem in the contralateral hind limb. In active or working dogs PITJ instability can occur as a consequence of a traumatic injury. Most patients present with a weight bearing lameness but with a plantigrade stance. The condition is differentiated form other causes of a plantigrade stance (e.g. Achilles mechanism ruptures) by clinical examination. Radiography – this may include stress radiographs - confirms the diagnosis. Surgery is always required to resolve PITJ instability, as the plantar ligamentous structures never heal with sufficient strength to prevent recurrence of the plantigrade stance. **Although a variety of surgical techniques have been described both PITJ instability (both luxation and subluxation) is best managed using robust internal fixation with a bone plate and screws applied to the lateral aspect of the hock** (Barnes and others 2013). With such internal fixation prolonged bandaging or external coaptation with a cast / splint is not required. With well-executed surgery the prognosis for return to function is excellent in most dogs.

Tarsometatarsal (TMT) luxation usually results from a traumatic event, although occasionally it is identified in dogs secondary to chronic degeneration of the supporting ligamentous structures. With plantar ligament injury TMT arthrodesis using a bone plate and screws is always indicated, placed either laterally or medially. Medial or lateral TMT collateral ligament rupture will result in varus or valgus instability, whilst dorsal ligament rupture will result in dorsal instability.

The latter injury usually results in pain and swelling of the TMT joint, although the instability can be difficult to diagnose, although with thorough orthopaedic and radiographic assessment diagnosis should be straightforward. When the plantar ligaments remain intact collateral injuries may be managed by prosthetic collateral ligament replacement (screw and nylon or wire prosthesis). Dorsal ligament injury can be managed by cast or splint stabilisation, with or without temporary K-wire fixation, or dorsal screw and wire fixation; however, when such weak internal fixation is used for such repairs external coaptation is required in the early postoperative period. In order to avoid the potential complications associated with external coaptation, this surgeon will use lateral or medial plate fixation for the majority of these dorsal +/- collateral ligament injuries; more robust internal fixation removes the requirement for postoperative external coaptation and facilitates a rapid and excellent return to function in most patients.

When undertaking partial tarsal arthrodesis attention should be paid to the following:

- Appropriate plate selection
- Appropriate skin incision location
- Appropriate plate contouring / bone sculpting
- Thorough articular cartilage debridement and bone graft placement
- Appropriate screw placement within the metatarsus – the key to success
- Tension free skin closure

Lateral and medial bone plate application remains a technically challenging procedure; unfortunately errors in technique and application remain the most likely reason for postoperative complications and / or poor limb function.

Useful reading

Allen and others (1993) Calcaneoquartal arthrodesis in the dog. Journal of Small Animal Practice 34 (5) 205-210

Barnes and others (2013) Complications of lateral plate fixation compared with tension band wiring and pin or lag screw fixation for calcaneoquartal arthrodesis. Veterinary and Comparative Orthopaedics & Traumatology 6 445-452

DeCamp CE, Martinez SA & Johnston SA: (1993) Pantarsal arthrodesis in dogs and cats: 11 cases (1983-1991). Journal of the American Animal Hospital Association 38:370-380

Dyce and others (1998) Arthrodesis of the tarsometatarsal joint using a laterally applied plate in 10 dogs. Journal of Small Animal Practice 39 (1) 19-22

Fettig and others (2002) Intertarsal and tarsometatarsal arthrodesis using 2.0/2.7mm or 2.7/3.5mm hybrid dynamic compression plates. JAAHA 38, 364-369

Fitzpatrick NM & Riordan JO (2004) Tarsal arthrodesis following traumatic fracture/luxation in cats: 16 partial and 12 pantarsal arthrodesis. Proceedings BSAVA Congress, Birmingham p 573

Gorse MJ, Earley TD & Aron DN (1991): Tarsocrural arthrodesis: long term functional results. Journal of the American Animal Hospital Association 27:231-235

Guillou RP, Frank JD, Sinnott MT et al (2008): In vitro mechanical evaluation of medial plating for pantarsal arthrodesis in dogs. American Journal of Veterinary Research 69: 1406-1412

Klause SE, Piermattei DL & Schwarz PD (1989): Tarso-crural arthrodesis: Complications and recommendations. Veterinary and Comparative Orthopaedics & Traumatology 3: 119-124

McKee WM, May C, Macias C et al: Pantarsal arthrodesis with a customised medial or lateral bone plate in 13 dogs. Veterinary Record 154: 165-170 2004

Meeson RL, Davidson C, Arthurs GI (2011) Soft tissue injuries associated with cast application for distal limb orthopaedic conditions. A retrospective study of sixty dog and cats. Veterinary and Comparative Orthopaedics & Traumatology 24:126-131

Roch and others (2008) Complications following tarsal arthrodesis using bone plate fixation in dogs. Journal of Small Animal Practice 49, 117-126 2008

Theoret M-C & Moens NMM (2007): The use of veterinary cuttable plates for carpal and tarsal arthrodesis in small dogs and cats. Canadian Veterinary Journal 48:165-168 2007

Voss and others (2004) Internal splinting of dorsal intertarsal instability in dogs and cats with the compact unilock 2.0/2.4mm TM system. Veterinary and Comparative Orthopaedics & Traumatology 17, 125-130