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IVOA

·Pancarpal Arthrodesis Plate·

An IVOA development

PCA User Guide

Introduction

Pancarpal arthrodesis (PCA) is an established surgical procedure used to salvage otherwise irreparable injuries of the canine carpus. The surgery involves removal of articular cartilage prior to placement of an autologous cancellous bone graft and fixation using a bone plate. Most often the plate is applied dorsally to the distal radius, radial carpal and the third metacarpal bone. After surgery, it has been generally recommended that a cast is applied to provide additional support during the early convalescent period.

Although usually successful, pancarpal arthrodesis is technically demanding and complications are not uncommon. Complications might be directly related to the surgery or associated with the cast and are often serious. Over the years, consideration has been given to alternative surgical techniques: external fixators are effective but technically very difficult to apply and a second anaesthetic/surgical procedure is inevitable. Fixation using a ventrally applied bone plate is biomechanically more appropriate than the widely used dorsal plate but significantly more difficult to place. A medially applied bone plate has been advocated but this requires considerable additional implant contouring and an undesirably straight arthrodesis. Consequently, most surgeons favour a modification of the traditional technique using a dorsally applied bone plate which, though imperfect, has been found to be reasonably effective. However, there remains considerable potential for improvement through further evolution of the design of PCA implant.

Design Considerations

In the normal standing dog, the carpus has 10-15° of extension. However, a review by Whitelock, Dyce and Houlton (1999) indicated that excellent cosmetic and functional results are obtained with an arthrodesis angle of approximately 8°. Using existing PCA implants, achieving an acceptable arthrodesis angle involved bending the plate over the carpus. Implant contouring leads to a loss of strength and stiffness in a plate that will subsequently be exposed to considerable stress. An implant which would achieve an arthrodesis angle of approximately 8 ° without the need for contouring was considered desirable.

The work by Whitelock, Dyce and Houlton (1999) revealed that fracture of Metacarpal III through the distal screw was the most common complication leading to failure of the arthrodesis. Further, it was shown that plates covering more than 50% of the metacarpal were less likely to cause fractures so an implant which would cover a large proportion of the metacarpal was, therefore, considered desirable.

Viguer and colleagues (2001), using cadaver limbs, demonstrated that when loaded incrementally a plate arthrodesis invariably failed by fracture through Metacarpal III so an implant which would attach distally to two metacarpals was, therefore considered desirable.

The incidence of minor, major and catastrophic complications related to the use of the cast, whilst nowhere documented, is likely to be considerable so an implant system which avoids the need for postoperative casting was considered desirable. (Clarke, Ferguson and Miller 2009).

Design Features

The implants are machined from surgical grade 316LVM stainless steel; batch marked and manufactured to internationally recognised ASTM standards. Each batch of raw material undergoes an intercrystalline corrosion test in accordance with ASTM A262. There are four larger (3.5/2 .7mm) implants varying in length from 110- 140 mm, and four smaller (2.7/2.0mm) implants varying in length from 60-85mm.

Proximally, four holes are designed to accept 3.5 mm screws (2.7mm screws in the smaller implants) two are round holes and two are oval to allow compression of the radius against the radial carpal bone. A single centrally placed round hole takes the screw to be placed into the radial carpal bone. All plates (within ranges) are identical proximally - it is the distal (metacarpal) part of the implant

which varies in length and this distal variation allows a plate to be selected which gives optimal coverage of the metacarpal bones.

Distally, there are three pairs of screw holes. The proximal pair of holes is placed close to midline and angled at 10°; the middle pair of holes is slightly more offset and angled at 20° and the most distal pair of holes is significantly offset from the midline and angled at 30°. This arrangement optimises the screw- bone contact and accommodates the anatomical divergence between metacarpals three and four distally. The biomechanically sympathetic fixation of the implant along most of the length of two metacarpals will minimise the risk of metacarpal fracture. Two small (0.8 mm) holes perforate the plate allowing a small K wire or hypodermic needle to be placed through the plate and into the space between metacarpals three and four to define and maintain accurate alignment of the implant.

The underside of the implant is smoothly contoured without “steps” which would act as stress risers. Proximally, a curved under surface conforms to the distal radius and radial carpal bone. Distally, the surface features a "keel" to accommodate the dorsal aspects of metacarpals three and four. Additionally, the implant is shaped to impose an arthrodesis angle of approximately 8° without the need to bend the plate.

Clinical Experience

At the time of writing, several hundred cases have already been operated using the CastLess PCA plate and published reports of the successful use of this implant have started to appear. (Clarke et al 2009).

References

Whitelock RG, Dyce J, and Houlton JEF. (1999) Metacarpal fractures associated with pan-carpal arthrodesis in dogs. Vet Surg 28(1):25-30,1999.

Viguier E , Znaty D, Medelci M, C Degueiearce (2001) Eq VetJ. Suppl. (33) 32-35,2001.

Clarke SP, Ferguson JF and Miller A. (2009) Clinical evaluation of Pancarpal Arthrodesis using a CastLess Plate in 11 dogs. Vet Surg 38:852-860,2009

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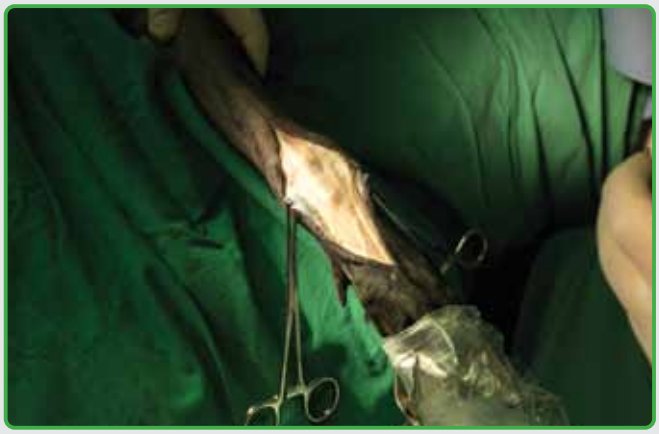

1 With the patient in lateral recumbency, the limb is clipped from dorsal mid-line to toe and draped such that the entire limb from shoulder to toe is exposed. An assistant externally rotates the leg such that the surgeon has comfortable access to the dorsal aspect of the distal limb.

2 A mid-line skin incision is made centred on the radial carpal bone, extending distally to stop just short of the metacarpo-phalangeal joints and extending proximally a similar distance. Care is taken to avoid inadvertently cutting underlying structures – especially branches of brachial veins proximally and the digital extensor tendons distally.

3 The digital extensor tedons are identified and dissected free. Gelpi self retaining retractors are placed at the level of the carpus to hold these important structures out of the surgical field.

4 The insertion of the tendon of the extensor carpi radialis muscle is identified.

5 The extensor carpi radialis tendon is incised across its insertion and reflected proximally.

6 The joint capsules and dorsal ligaments of all three parts of the carpal joint (antebrachio-carpal; inter carpal and carpal-metacarpal) are identified and excised using a sharp scalpel. A careful and methodical approach informed by a sound understanding of carpal anatomy is required. Care is taken to avoid injury to retracted extensor tendons, vascular structures and the collateral ligaments which should be preserved.

7 The dissection is complete – all carpal bones are well exposed and easily accessed.

8 Flexion of the carpus with judicious use of a Hohmann retractor provides useful surgical access to a wider surface area of each joint..

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9 The requirement is to debride each individual joint surface of its articular cartilage – “back to bleeding bone” but be aware that in the smaller bones especially, it is not always easy to see the bones actually bleed. Several techniques have been described for the removal of articular cartilage – the use of a fast “spinal” bur is the easiest and quickest way of achieving a reliably thorough job. Again, a methodical approach to each joint in turn is recommended.

10 Once all articular cartilage has been removed, numerous small diameter holes are drilled 1mm – 2mm deep into each joint surface to give a “honey-comb” or “Swiss-cheese” network of vascular access channels.

11 The appropriate size of Castless PCA plate is placed on the bone such that the “keel” on the underside of the plate lies between metacarpal (MC) 3 and 4. The central round hole (hole number 5 counting from the top) must lie directly over the radial carpal bone.

(The proximal part of the Castless PCA plate – above the radial carpal screw hole (hole number 5) - is identical between all sizes of plate. The length of the distal portion varies. With reference to the dorso-palmar presurgical radiograph, the surgeon should select the longest plate that will comfortably fit over metacarpals 3 and 4)

12 The central alignment of the plate is maintained by placing two 21 gauge hypodermic needles through the small pin holes in the plate and between MCs 3 and 4. (Arthrodesis wires or Kirschner wires can be used in place of the hypodermic needles)

13 The carpus and plate are held in alignment while a 2.5mm hole is made through plate hole number 5 and into the radial carpal bone.

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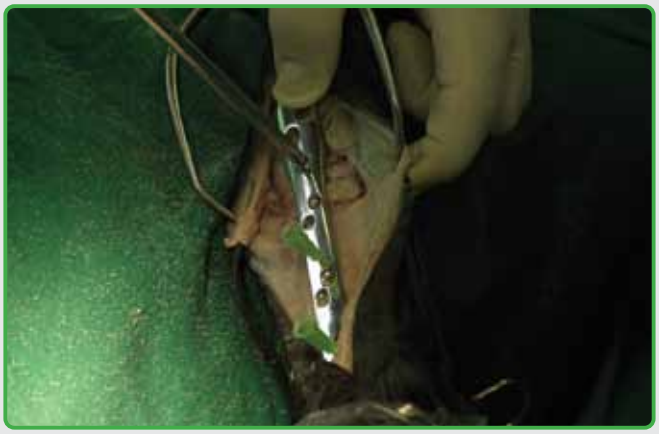

14 A screw of appropriate length is selected and placed – the screw is tightened down to touch the plate but is NOT YET fully tightened at this stage.

15 The central pair of distal holes are oval “load” holes and these are the next screws to be placed. A standard AO type compression drill guide is used with a 2.0mm drill bit. Note that the distal screw holes are sequentially angled to provide better positioning of the screw within the metacarpal bone.

16 It is important that both of the central pair of screws is placed before either is tightened. The hypodermic needles/wires should be removed now or they will become jammed once these first two screws are tightened. Beware that the metacarpals are small bones and it is very easy to over-tighten the MC screws.

17 The remaining two pairs of MC screws are placed using a neutral drill guide and a 2.0 mm drill. Take care to respect the angulations of these distal screw holes – the first pair of holes is angled off perpendicular at 10 degrees, the second pair at 20 degrees and the most distal pair at 30 degrees.

18 The plate and the now firmly attached distal part of the carpus is properly aligned before the first radial screw hole is made. Using the compression end of a standard AO type drill guide and a 2.5mm drill, a hole is made in the distal radius.

19 A screw of appropriate length is selected and placed but NOT YET fully tightened.

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(At this stage a cancellous bone autograft is collected from the proximal metaphysis of the ipselateral humerus. The graft is packed into each level of the carpus and the two not yet fully driven 3.5mm screws are tightened down.)

20 The remaining screws are drilled and placed in the distal radius using standard technique before the digital extensor tendons are released from behind the Gelpi retractors. The previously sectioned tendon of insertion of the extensor carpi radialis is replaced and sutured prior to an otherwise routine wound closure. A light dressing is used to control wound swelling and this is removed 5-7 days after surgery.

X-rays courtesy of John Ferguson BVM&S Cert SAO MRCVS, East Neuk Veterinary Surgery.

21 Pre-Op X-Ray
22 Immediately Post-Op X-Ray
23 7½ Weeks Post-Op X-Ray

Notes

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