Elbow and stifle arthrodesis using the Fixin system

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FIXIN FEATURES AND MECHANICAL PRINCIPLES
The main complications associated with plate fixation are loosening/failure of the screws, impaired periosteal and cortical blood supply directly beneath the plate and excessive shielding of stresses from the bone. Non-contact locking plates could offer certain advantages in arthrodesis fixation over conventional plating methods. Locking plates work as an internal skeletal fixator. Screws are locked into the plate as they are inserted into the bone. Because of this fixed screw mechanism, bone’s threads are unlikely to become stripped during screw insertion and are more resistant to implant failure. The locked position of the screws into the plate negates screw angulation and compression between bone fragments. The locking mechanism of the Fixin system is achieved by a conical coupling between the screw head and a bushing insert which is screwed into the plate. The outer surface of the screw head is conically shaped, corresponding with the internal surface of the bushing. The stability of the screw-bushing coupling is achieved by friction, micro-welding and elastic deformation between the head of the screw and the bushing. The presence of the bushings allows for easier implant removal by either removing the screw from the insert or unthreading the bushing from the plate. This intermediary fixation diminishes concerns of implant removal difficulties secondary to cold-welding, cross threading or damage to the screw hexagonal recess as has been reported with other locking plate systems. The Fixin plate is composed of AISI 316LVM stainless steel. Straight plates of various thicknesses ranging from 1.2mm to 3mm are available ranging from four to eight holes with varying lengths. The bushings are made of titanium alloy Ti6Al4V. Fixin screws are made of titanium alloy Ti-6Al-4V; they are self-tapping locking screws.

ARTHRODESIS
An arthrodesis is a pain relieving procedure where an induction of joint fusion (ankylosis) is performed via surgery. Arthrodesis are salvage procedures for canine joint hyperextension injuries, irreparable multiple ligament damage, severe osteoarthritis, irreparable intrarticular fractures, chronic luxations or subluxations, gunshot fractures, shearing injuries, congenital or developmental malformations, limb sparing in case of tumor involving the joint itself or the surrounding bone segments, failure of surgical procedures performed to treat the cranial cruciate ligament rupture or to treat patellar luxation and finally in case of removal of prosthetic implants. In general, an arthrodesis involves debridement of the joint cartilage or removal of the joint surfaces using an oscillating saw, application of a bone autograft (cancellous bone), and a stable fixation, either with a bone plate or with an external skeletal fixator (linear or circular). High postoperative complication rates have been described with arthrodeses. Complications of arthrodesis include failure to fuse, implant/fixation failure (screw loosening/breakage or plate breakage), bone fractures, infection, skin necrosis and bandage/cast related complications.

In veterinary medicine, there are several scientific publications, which describe the panarthrodesis and the partial carpal and tarsal arthrodesis performed using various surgical techniques, the possible complications and success rate. Only few cases of elbow and stifle arthrodeses have been reported in the relevant literature. No reports concerning the use of locking plates for elbow and stifle arthrodeses in dogs are available. The aim of this presentation was to review advantages and disadvantages of these implants in clinical elbow and stifle arthrodeses cases without any external coaptation (casts, splints or bandages). Complications were evaluated and analysed in the perspective of developing preventive measures through the modification of the use of the Fixin system.

MATERIALS AND METHODS
The medical records of dogs, presented to three surgical referral centres between April 2008 and June 2012, with severe elbow and stifle injury that had arthrodesis stabilized solely with Fixin locking plate system were reviewed. Information relative to the history and the diagnosis of the patients were obtained from medical records. Information obtained from the medical records were breed, gender, age (months), weight (kilograms), which limb was affected (right or left). Surgical techniques adopted and application techniques of the implants have been described by the literature. Straight plates were pre-bent to allow them to adhere to the bone surfaces as much as possible and to obtain the suggested angle between the proximal and the distal half of the plate.
**INCLUSION CRITERIA**
The arthrodesis had to be stabilized only with the Fixin system plate. Inclusion criteria included the availability of preoperative, immediate postoperative and radiographic follow-ups taken at least 60 days postoperatively.

**POSTOPERATIVE CARE**
All patients were prescribed anti-inflammatory and pain medication in addition to antibiotics prophylaxis at individual dosages. Cage rest and short daily leash walks were recommended until radiographic bone healing was observed.

**OUTCOME EVALUATION**
The patients were periodically evaluated until their full recovery both from a clinical and from a radiographic point of view. The timing of clinical and radiographic re-examinations was recorded in weeks. Arthrodesis was considered healed when the radiographic evidence of a callus was observed. The radiographic checks carried out after the recovery from the arthrodesis and long term after the procedure were done to monitor any bone reabsorption in the screw-bone area. Any complications related to the implant or with the surgical procedure were recorded. Complications were classified as short-term if they developed within the first 30 days following surgery and long-term if they developed after 30 days following surgery. Complications were deemed as minor if they did not require a revision surgery. Complications were deemed as major if a revision surgery was required for bone healing. Complications were classified as “implant failures” or as “other complications”. Implant failures included: plate or screws breakage, plate bending and screws pullout. Other complications included problems not related to implant failures (skin incision, improper reduction with axial deviation, osteomyelitis).

Limb function, evaluated over 60 days following surgery, was classified as normal, mechanical lameness and non weight-bearing lameness.

**PATIENT DESCRIPTION**
The medical records and post-operative radiographs of 7 dogs that had arthrodesis with Fixin locking plate system were reviewed (six stifle and one elbow arthrodesis).

Stifle arthrodeses: one Pomeranian, one Fox Terrier, one Toy Poodle, one German Shepherd and two small size mongrels. The mean age was 51 months (from 9 to 107 months) and the mean weight was 13 Kg (from 3.1 to 34 Kg). Five dogs were male and one was female. Three arthrodeses were performed on the right stifle and three on the left one.

Elbow arthrodeses: one Labrador retriever, female, 14-month-old, 26 Kg, left side.

**HISTORY AND DIAGNOSIS**
In all 7 patients the preoperative views showed severe alterations of the joint which were the cause of the clinical symptoms such as severe lameness, decrease of range of motion (ROM), and pain upon passive motion on flexion and extension.

In 4 cases out of 6 the stifle arthrodesis was necessary because of a failure of a previous procedure. In case #1 the arthrodesis procedure was performed after a traumatic and chronic stifle luxation (collaterals and cruciate ligaments rupture). The patient had a severe cranial subluxation of the tibia. Dog #2 got a severe chronic patellar tendon lesion during a tibial tuberosity transposition. Arthroscopic evaluation showed osteoarthritic alterations and a severe erosion of the articular cartilage over the femoral condyles. Two months after a TPLO (Tibial Plateau Levelling Osteotomy) procedure subject #3 was run over by a car, suffering a rupture of the stifle lateral collateral ligament and a fracture of the tibial tuberosity. The revision surgery failed and the patient faced severe osteoarthritic changes and poor stifle ROM. In case #4 a lateral transposition of the tibial tuberosity was incorrectly carried out in presence of a lateral patellar luxation. The patient was examined months after the surgery showing severe stifle osteoarthritis. Case #5 underwent an osteosynthesis after a femur distal fracture. During surgery the screws were incorrectly positioned, thus causing serious and irreparable damage to the joint cartilage. Case #6 had severe alterations of the knee anatomy following a distal femoral joint fracture that was never treated.

The elbow arthrodesis was necessary to treat a severe elbow dysplasia with complete cartilage lost.

**POSTOPERATIVE RADIOGRAPHIC ASSESSMENT**
The stifle arthrodesis angles measured in the post-operative radiographs ranged between 105° and 145° (mean 130°, median 135°).

The elbow arthrodesis angle measured in the post-operative radiographs was 110°.
RADIOGRAPHIC OUTCOME

The radiographic follow-ups were carried out between 3 and 52 weeks after the procedure. All arthrodesis healed. Radiographic healing of the osteotomies was noted at the radiographic checks at: 20 weeks in case #1, 10 weeks in case #2, 16 weeks in case #3, 8 weeks in case #4, 7 weeks in case #5, 15 weeks in case #6 and 10 weeks in case #7 (elbow).

COMPLICATIONS

In three cases a complication occurred. Two complications were classified as short-term, major complications. One complication classified as minor and fixation failure. One complication happened intra-operatively in case #6 and during the post-operative period in case #4. A fissure of the cranial cortex of the tibial diaphysis occurred in case #6 tightening the distal screw. A second Fixin plate was applied to treat the hyatrogenic fracture. The second implant used was a Fixin hybrid plate allowing accommodation of both large series screws (3.0 and 3.5 mm in diameter) and mini series screws (1.9 and 2.5 mm in diameter), designed for tarsal panarthrodesis. This kind of implant positioned on the lateral side of the bone segments, allowed the insertion of two 3.0 mm screws in the femur and three 1.9mm screws in the tibial diaphysis.

Dog #4 fractured his tibia diaphysis, at the level of the last distal screw, after being trampled by a runner 20 days after surgery. A revision surgery took place with using a 6 holes Fixin plate on the medial side of the tibia. Eighty days after the first surgery (60 days after the second) the radiographic follow-up showed the healing of the arthrodesis.

Dog #7 got one screw breakage that was detected at 10 weeks follow-up without any clinical concern.

CLINICAL OUTCOME

All cases presented mechanical lameness. Case #1 (arthrodesis angle = 105°) and case #5 (arthrodesis angle = 118°) were walking with full weight bearing but barely toe touching while standing.

The results of this retrospective study indicated that elbow and stifle arthrodeses using Fixin system provided acceptable restoration of limb function after irreparable disease or injury.

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