Fixin internal fixator: Concept and technique

M. Petazzoni1; A. Urizzi2; B. Verdonck3; G. Jaeger4
1Clinica Veterinaria Milano Sud, Peschiera Borromeo (MI), Italy; 2Clinica Veterinaria Dott., Urizzi, San Michele al Tagliamento (VE), Italy; 3Huisdierchirurgie, Boechout, Belgium; 4VCA Newark, Newark, Delaware, USA

Keywords
Internal fixator, osteosynthesis, locking plates, angle-stable plates, conical coupling

Summary
This report describes the Fixin internal fixator system, a fracture fixation device characterised by a locking conical coupling between screw heads and titanium alloy inserts that are screwed into a stainless steel plate construct. The mechanical principles, implants, instruments and surgical technique are discussed.

Correspondence to:
Massimo Petazzoni, DVM
Clinica Veterinaria Milano Sud
Orthopaedics and Traumatology
Via Liberazione 26
20068 Peschiera Borromeo (MI)
Italy
Phone: +39 02 55 30 55 68
Fax: +39 02 55 30 62 88
Email:massimo.petazzoni@cvmilanosud.it

Vet Comp Orthop Traumatol 2010; 23: 250–253
doi:10.3415/VCOT-09-10-0108
Received: October 15, 2009
Accepted: February 11, 2010
Pre-published online: June 21, 2010

Introduction
Recently, the management goals for orthopaedic trauma have shifted in emphasis from anatomical reconstruction and absolute stability to mechanical alignment, appropriate stability and atraumatic soft tissue techniques (1, 2). The introduction of new implants has made biological internal fixation a more practical proposition and widened its range of application (1, 2). The purpose of this brief communication is to describe the Fixin system, a new angle-stable internal fixator.

Biomechanics of internal fixators and Fixin
Conventional non-locking plates achieve their stability from the compression of the plate against the bone, which is directly proportional to the lag force that is applied to the plate by screw tightening. Locking plates act as an internal skeletal fixator since the screws are locked into the plate as they are inserted into the bone, thereby minimising plate-bone contact and damage to the periosteal blood supply (1, 2). The fixed position of the screws into the plate prevents screw angulation and compression between the bone fragments (2, 3). However, because of this fixed screw position, the threads cut in the bone are unlikely to become stripped during screw insertion and are more resilient to screw pull-out and implant loosening.

The Fixin system, a locking, screw-insert-plate construct differs from other available locking systems by: 1) a conical coupling locking mechanism between the screw head and bushing-insert-plate construct, 2) an intermediary bushing-like insert which locks the screw and threads into the support plate (Fig. 1), and 3) the option for implant removal (2) (Fig. 2). The intermediary bushing-insert and locking mechanism allows for easy implant removal by either removing the screw from the insert-plate construct or unthreading the screw-insert construct from the plate. This intermediary fixation negates concerns of implant removal complications secondary to cold-welding, cross threading or damage to the screw hexagonal recess as has been reported with other locking plate systems (4). This combination of mechanical features makes the Fixin system angle-stable, simple to apply, and easy to remove (2).

Fixin implants and instruments
The Fixin support plate is composed of AISI 316LVM stainless-steel, with threaded holes in which the externally-threaded bushing-inserts can be secured (Fig. 1). Support plates of 1.2 mm, 1.5 mm, 2.0 mm, 2.5 mm and 3 mm thickness are available ranging from four to eight holes with varying lengths. Angled or pre-contoured plates (tibial plateau levelling osteotomy, triple pelvic osteotomy, panpcarpal and pantarsal arthrodesis plates) are also available.

The bushing-inserts are made of titanium alloy Ti-6Al-4V (Fig. 1). The inner surface of the bushing-insert is conically shaped to engage and secure the head of the screw (Fig. 1) and external threads are present for fixation into the plate. External grooves on the superficial edge of the bushing-insert couple with the specially designed insert device, an instrument used to thread the insert into and from the support plate (Fig. 2). There is a designated bushing-insert for both the mini (yellow) and large (blue) series of implants.

Fixin screws are self-tapping locking screws, which are made of titanium alloy Ti-6Al-4V. These screws are designed with smaller threads than non-locking screws because they are not intended to generate compression between the plate and the bone. However, they have a larger core diameter, which increases screw bending and shear strength, and improves load dissipation over a larger area of bone (2). The outer surface of the screw head is conical-shaped, corresponding with the conically shaped internal surface of the bushing-insert...
sert. The stability of the screw-insert coupling is achieved by friction, micro-welding and elastic deformation between the contact surfaces of the head of the screw and the bushing-insert (2). The Fixin mini-implant series can accommodate either 1.9 mm or 2.5 mm screws, based on their thread diameter, whereas the Fixin large-implant series can accommodate either 3.0 mm or 3.5 mm screws. The head of the screw has a hexagonal recess to fit standard 2.0 mm and the 2.5 mm screwdrivers in the mini and large systems, respectively. To aid in implant selection, as a general rule the mini system is recommended to stabilise fractures in cats and small dogs up to 10 kg.

The rationale for the material selection of the implants is based on optimising the stiffness and strength of the implants while matching the modulus of the implant to the bone. Previous concerns regarding implant weakening or galvanic or fretting corrosion as a result of using a combination of titanium alloy and stainless steel for the implants are currently unfounded (5).

Surgical technique

Distraction, realignment, and apposition of bone fragments is performed in a routine manner while minimising aggressive manipulation of the fragments to preserve the blood supply. Approximate contouring of the support plate is advocated, though not essential, to reduce the distance between the bone and the plate; this decreases soft tissue irritation and impingement, allows for proper positioning of the plate on the bone, and increases the overall stiffness of the construct. Bending the plate directly over the inserts should be avoided to prevent deformation of the insert which can affect the screw-insert coupling mechanism. As long as the bushing-inserts are not deformed, extreme bending of the plate can be achieved.

Prior to drilling, the plate is provisionally secured to the bone with either bone-clamps or with pins and pin-stoppers (Fig. 3). This allows for evaluation of proper plate positioning along the center of the bone. Immobilisation of the plate during the drilling process prevents fragment translation, ensures adequate screw purchase into the bone, allows for appropriate coupling of the screw-inserts, and increases overall implant stability. A drill-guide unique to the Fixin system with a conical tip secured into the interior surface of the bushing-insert is used for an accurately positioned drill hole perpendicular to the plate (Fig. 4). Precise drilling of the screw holes is required for maximum stability of the conical coupling mechanism between screw and insert. After drilling and measuring the screw hole with a depth gauge, the self-tapping screw is inserted and secured into the plate and bone. When appropriate screw-insert coupling is achieved, the screw head should be flush with the insert. When the screw head emerges more than 1 mm above the insert, the screw has not been fully inserted and is not locked within the insert-plate construct.

A minimum of three bicortical screws are recommended in each fracture segment for fracture healing when locking systems are used (3). The recommended diameter of the screw should be 25% of the bone diameter (3). Using large bicortical screws can minimise the occurrence of a rake or plough phenomenon, which results from loss of reduction and stability of the plate construct as the screws slice through thin bone cortices or poor quality bone.

In metaphyseal or juxta-articular regions, placement of angle-stable screws can be difficult and may result in injury to the physeal plate or intra-articular implant placement. In such instances, a shorter monocortical screw can be placed or alternatively, the bushing-insert can be removed and a standard 3.5 or 4.0 mm screw inserted directly into the hole of the support plate.
For additional fracture stabilisation, two Fixin plates can be placed side by side or a second plate can be added orthogonally to the first, similar in principle to a biplanar external fixator. Hybrid techniques combining the benefits of other implants including intramedullary pins, cerclage wire, pins, tension bands, or screws placed in lag fashion are also possible. Minimally invasive approaches can be an option for fracture treatment, particularly of the tibia where there is minimal soft tissue coverage and adequate assessment of limb alignment can be made (2, 6) (Fig. 5). After the bone is healed, the implants can easily be removed by unthreading the screws or the inserts from the plate with the screwdriver or the insert device (Fig. 2).

Discussion

The Fixin system presents several technical novelties that may be advantageous over the other available locking systems. Implant removal in the threaded locking systems can be difficult after the cold-welding or cross-threading between the plate and screws as removal may require transection of the screw beneath the plate or transection of the plate itself between each screw (4). The presence of the intermediate insert and locking mechanism in the Fixin system allows for implant removal either by uncoupling of the screw from the insert or unthreading the insert from the plate. An additional advantage of incorporating an intermediate bushing is that the thickness...
required for adequate conical coupling is not related to the thickness required for the plate. This allows for the construction of thin implants, which is beneficial for several reasons: 1) with angle-stable screws, changes in screw position is achieved through contouring of the locking plate and thin plates are more easily contoured, 2) thin plates are more amenable to minimal invasive plating osteosynthesis, 3) thin plates are ideal for distal extremities treatments where there is less soft tissue coverage, and 4) thin implants can act in an elastic manner similar to an external fixator stimulating callus formation and bone healing.

No mechanical testing has been performed to evaluate the stability or stiffness of this system, nor have its potential advantages been compared to other locking plate systems for fracture healing. Evaluation of the O’Nil System, the human equivalent of the Fixin system assessed stress distribution in two different loading conditions (screw tension and bending) by means of three-dimensional finite element models (2). This study concluded that the highest stress was found in the screw neck and the bushing-insert, which helps improve the stress distribution on the plate and may reduce the likelihood of stress-shielding (2). Future studies are needed to prospectively evaluate both experimentally and clinically the performance of the Fixin system.

Acknowledgements
We thank the following people for their help provided: Nilli Del Medico, Piero Costa, Antonio Pozzi, Davide Albertini.

Conflict of interest
Authors Massimo Petazzoni and Andrea Urizzi are partners of Traumavet, the company which owns the patents on, produces and sells the Fixin system. Author Bart Verdonck is a partner at Fixovet, a company which distributes the Fixin system in Belgium and The Netherlands.

References