Repair of long-bone fractures in cats and small dogs with the Unilock mandible locking plate system

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Abstract

Objectives: To retrospectively evaluate stabilisation of long-bone fractures in cats and small dogs using the Unilock system. Methods: Medical histories and radiographs of consecutive patients with long-bone fractures stabilised with the Unilock system were reviewed. Cases with follow-up radiographs taken at least four weeks postoperatively were included. Signalment of the patient, fracture localisation and type, primary fracture repair or revision surgery, single or double plating, and complications for each patient were noted. Additionally, implant size, number of screws, number of cortices engaged with screws, and number of empty holes across the fracture were evaluated in fractures where a single plate had been applied. Results: Eighteen humeral, 18 radial, 20 femoral, and 10 tibial fractures were treated. The Unilock system was used for primary repair in 44 fractures and for revision surgery in 22 fractures. Two plates were applied in 17 fractures, and a single plate was applied in 49 fractures. Follow-up radiographs were taken four to 109 weeks postoperatively. Complications were seen in 12 animals and 13 fractures (19.7%). Fixation failure occurred in seven fractures (10.6%). Cases with a single plate that suffered fixation failure had thinner screws in relation to bone diameter than cases with double plates, and more screws in a main fragment than those without fixation failure. Clinical significance: The Unilock system is a suitable implant for fracture fixation of long bones in cats and small dogs.
Repair of long-bone fractures in cats and small dogs with the Unilock mandible locking plate system

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Key Words
Internal fixator, Unilock system, fractures, long bones, complications

Summary

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Methods: Medical histories and radiographs of consecutive patients with long-bone fractures stabilised with the Unilock system were reviewed. Cases with follow-up radiographs taken at least four weeks postoperatively were included. Signalement of the patient, fracture localisation and type, primary fracture repair or revision surgery, single or double plating, and complications for each patient were noted. Additionally, implant size, number of screws, number of cortices engaged with screws, and number of empty holes across the fracture were evaluated in fractures where a single plate had been applied.

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Clinical significance: The Unilock system is a suitable implant for fracture fixation of long bones in cats and small dogs.

Introduction

Internal fixators, or locking plates, are recently developed implants for osteosynthesis. An internal fixator has a locking mechanism between the screw heads and the plate holes. This mechanism creates an inherent stability between the screw heads and the plate, similar to the properties of an external skeletal fixator. Fixation stability therefore does not rely on friction created by compression of the plate onto the bone as with conventional plates.

The ability to apply an internal implant with minimal or no contact with the underlying bone has several biological advantages over conventional plating. Experimental and clinical studies in human surgery have generally shown internal fixators to be superior to conventional plates in terms of simplicity of handling, progression of fracture healing, and local resistance to infection (1–3). Internal fixators do not require perfect contouring to the bone surface to maintain fracture reduction; this reduces surgery time and allows biological fracture treatment by using a limited open approach. Surgical times are also shorter when using internal fixators because the screws are self-tapping and can be self-cutting as well. Construct stability and resistance to screw loosening or pull-out have been reported to be superior with internal fixators in comparison to conventional plates (4, 5). Furthermore, because locking screws are under minimal tensile preload, they do not need to engage two cortices and can be inserted monocortically (1).

The first internal fixator to demonstrate the concepts of this new generation of implants was the PC-Fix, developed by the AO (Arbeitsgemeinschaft für Osteosynthese-fragen) Institute in Davos, Switzerland (2, 3, 6, 7). Further developments have led to a variety of different internal fixators now available on the market, with the locking compression plate1 from Synthes probably being the most commonly used system for stabilisation of long-bone fractures.

The interest in using internal fixators for fracture fixation in veterinary surgery is emerging despite the relatively high implant costs (8–10). The findings of biomechanical studies have led to the formulation of application principles for use of internal fixators in osteosynthesis of long-bone fractures in humans (4, 11). Some of these application principles may be transferred to veterinary orthopaedics. However, in contrast to human surgery where internal fixators are often used as a

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semi-rigid stabilisation (1), fracture stabilisation in animal patients should be strong enough to allow immediate postoperative weight bearing (9). Also, the size of bones, thickness of cortices, and forces to be counteracted may not be comparable between human and small animal patients.

The Unilock mandible locking plate system is an internal fixator that has been used in small animals for several years at our institution, the Vetsuisse Faculty University of Zurich. The Unilock system was designed for treatment of mandibular fractures in humans, and has been proven to be a suitable implant for this indication in both biomechanical and clinical studies (12, 13). We started applying the system for long-bone fracture stabilisation in cats and small dogs because at that time other internal fixators were not widely available in the appropriate sizes for the bones of small patients. The specifications of the Unilock implants and instruments, as well as their possible indications for fracture repair in small animals have been described earlier (10). The 2.0 mm system comes in plates of three different thicknesses; 1.0 mm 1.3 mm and 1.5 mm. The 2.4 mm system has a plate thickness of 2.5 mm and can be used with 2.4 mm and 3.0 mm screws. The Unilock reconstruction plates are available in different lengths, and are cuttable. Plates and screws in all systems are made of titanium.

This retrospective study was aimed at describing outcomes of patients with long-bone fractures that were stabilised with the Unilock system. In order to formulate recommendations for the clinical use of the system in fracture repair of small dogs and cats, we also evaluated parameters that could potentially influence construct stability, and occurrence of fixation failure.

Material and methods

Inclusion criteria

Medical histories and radiographs of cats and dogs with long bone fractures stabilised with the 2.0/2.4 Unilock mandible locking plate system from May 2002 through September 2006 were reviewed. Only cases with follow-up radiographs taken at least four weeks postoperatively were included in the study. The owners of dogs and cats without adequate follow-up were contacted by telephone, and were included if they were available for a clinical and radiographic follow-up examination at that time.

Patient and fracture description

The following parameters were recorded for all patients: Dog or cat, breed, age (months), body weight (kg), fractured bone (humerus, radius/ulna, femur, tibia), fracture localisation, and fracture type. Fracture localisation was classified as diaphyseal, metaphyseal or articular. Fracture type was either simple transverse or short oblique, simple long oblique or spiral, multifragmentary reducible (no more than two large cortical fragments in the fracture zone), and comminuted (more than two cortical fragments in the fracture zone). There was an additional fracture type category for patients where a delayed union or non-union was treated. It was determined whether the Unilock system was used as an implant for primary fracture fixation, or if it was used in a revision surgery of a previously failed osteosynthesis or a fracture union disorder. The number of surgeons using the system was also documented.

Description of stabilisation method

It was noted if a single Unilock plate was applied or if double plating was used. The following parameters were recorded or measured on postoperative radiographs in patients with a single Unilock plate: thickness of the plate (small, middle or large 2.0 mm plate, or 2.4 mm plate), ratio between bone and plate length, number of screws and cortices engaged with screws possible per plate, and number of screws and cortices engaged with screws possible per main fragment. If the numbers of screws or cortices differed between the two main fragments, the numbers were evaluated from the main fragment where fewer screws had been inserted. Additionally, the number of empty screw holes across the fracture zone, the ratio between screw and bone diameter at the most narrow aspect of the bone, and the presence or absence of concurrent use of ancillary implants such as lag screws, intramedullary pins, or Kirschner wires were noted.

Evaluation of outcome

Outcome was evaluated based on the information from medical records and follow-up radiographs. Time of follow-up examination was recorded in weeks. Cases with radiographic signs of good progression of healing and no signs of implant loosening or other problems at follow-up were assumed to be free of complications for statistical analysis, even if fracture healing was not completed. Complications were noted and were either classified as fixation failures or as other complications. Fixation failures included implant failure, screw pull-out, and iatrogenic fissures or fractures. Other complications included problems with the incision or the overlying skin, improper reduction with more than 10° axial deviation, and development of significant osteoarthritis in cases with joint fractures. Only complications relating to fixation failure were evaluated statistically.

Statistical analysis

Data were analyzed by use of statistical software. A Chi Square test was used to evaluate differences in the occurrence of fixation failure between cases with single or double plating. Additional statistical tests were performed in patients where a single plate had been applied to obtain further information on stability of the Unilock system. For this purpose, cases with fixation failure were compared to cases with no complications for differences in: cat or dog, body weight, age, affected bone, fracture localisation, fracture type, primary or revision surgery, size of the plate, ratio between bone and plate length, total amount of screws inserted per plate, total amount of cortices engaged with screws, amount of screws in the main fragment where fewer screws had been inserted, amount of cortices engaged with screws in...

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the main fragment with fewer screws, number of empty screw holes across the fracture, ratio between bone and screw diameter at the most narrow aspect of the bone, length of the shortest main fragment of the bone, and presence or absence of concurrent use of other implants such as lag screws, intramedullary nails, or pins. Chi Square test was used to compare cases with fixation failures or no complications with categorical data, and unpaired t-test was performed to compare them with continuous data. Significance was set as $P < 0.05$.

Results

Patient and fracture description

Seventy-four long-bone fractures in 30 dogs and 37 cats were stabilised with the 2.0/2.4 Unilock mandible locking plate system in the time period examined. The study in total included 66 fractures in 60 patients (34 fractures in 28 dogs, and 32 fractures in 32 in cats) for which there were follow-up examinations and radiographs taken at least four weeks postoperatively. In these cases, the surgery had been performed by twelve different surgeons who were either a diplomate of the European College of Veterinary Surgeons (ECVS) or an ECVS resident.

Age of the patients ranged from four- to 192-months-old (mean 36.5 months). Body weights ranged between 2.0 and 13.0 kg (mean 5.0 kg). Eighteen humeral fractures, 18 radial/ulnar fractures, 20 femoral fractures, and 10 tibial fractures were treated (Supplementary Tables 1–4: Available online at http://www.VCOT-online.com). Forty-eight fractures were located in the diaphysis, 10 in the metaphysis, and eight fractures involved the elbow (seven) or stifle joint (one). Twenty-one fractures were simple transverse or short oblique, 12 were long oblique or spiral, six fractures were multifragmentary reducible, and 19 were comminuted. Eight patients were treated for a fracture union disorder, of which two were considered to have a delayed union, and six a non-union. The Unilock system was applied as a primary stabilisation implant in 44 fractures (19 dogs and 25 cats). It was used for revision surgeries after previously failed osteosynthesis, or for the treatment of fracture union disorders in 22 cases (15 dogs and 7 cats).

Description of stabilisation method

A single plate was applied in 49 fractures and double plating was used in 17 fractures. The

Fig. 1 Diaphyseal tibia fracture stabilised with a 2.4 mm Unilock plate. A and B) Postoperative radiographs of a cat tibia that needed revision surgery after an external skeletal fixator had caused an iatrogenic fracture. Monocortical screws were inserted in the diaphyseal area and bicortical screws in the metaphyseal area. C and D) Radiographs after 10 months showing complication-free healing.
most common applications for double plating were distal humeral and femoral fractures. The shortest distal fragment stabilised with two plates was 6 mm long. Double plating was also used to stabilise three non-unions. One or more ancillary implants were used in 21 cases, including a lag screw for stabilisation of joint fractures in eight cases, an interfragmentary lag screw in a long oblique fracture, one or two small diameter Kirschner wires in eight cases with supracondylar fractures, and intramedullary pins in nine cases with diaphyseal fractures. The 2.4 mm Unilock system was applied in 30 fractures, and the 2.0 system in 36 fractures. The small 2.0 mm plate was applied in one case, the medium 2.0 mm plate in 16 cases, and the large 2.0 mm plate in 19 cases. The 2.4 mm Unilock system was usually used for stabilisation of diaphyseal fractures (Fig. 1). The 2.0 mm system was also applied for diaphyseal fractures, most commonly of the radius. In addition, it was often used for treatment of fractures located in the distal aspect of the humerus or femur. Double plating was only performed with the 2.0 mm system (Fig. 2).

Two to nine screws (mean 6.1) per plate were inserted in the cases where a single plate had been applied; the screws engaged between three and 16 cortices (mean 10.3) cortices. Between one and four screws (mean 2.6) had been inserted into the main fragment that had fewer screws. These screws engaged one to eight cortices (mean 4.2 cortices). Two or less cortices were engaged with the screws in only four patients, in which fractures were located close to a joint. Additional pins were used in three of these four cases. The ratio between bone and plate length was 0.27 to 1.03 (mean 0.62), and the bone to screw diameter ratio was 0.22 to 0.40 (mean 0.31). Between zero and seven plate holes (mean 1.41) were left empty between the screws that were near the fracture.

**Outcome and complications**

Follow-up examinations and radiographs were performed between four and 109 weeks (mean 22 weeks) after the initial surgery. Forty-five fractures had healed (determined by continuity of at least three cortices on orthogonal radiographs), four fractures seemed to have healed but not all cortices were visible on radiographs, and healing was considered to be under progression, albeit not complete in 12 fractures. For purpose of statistical analysis, all of these fractures were considered healed. All eight delayed unions or non-unions had healed (Fig. 3). In five fractures with complications, healing after the initial surgery could not be evaluated due to necessity of revision surgery before the four-week follow-up period examination.

Complications with the Unilock system were encountered in 12 animals and 13 fractures (19.7%). Seven complications involved the humerus, three the radius, and three the femur (Online Supplementary Tables 1–4). Seven complications were classified as fixation failures and included: breakage of 2.4 mm screws in one fracture, failure of 2.0 mm plates in two fractures (Fig. 4), inadequate insertion and/or avulsion of 2.4 mm screws in two fractures (Fig. 5), and iatrogenic fissure or fracture in two cats where the 2.4 system had been used. The fractured 2.0 mm plates had been applied in dogs weighing 6.5 kg and 9.8 kg for fractures located close to the elbow and stifle joint respectively. The dog with the distal humeral fracture (body weight of 9.8 kg) was the only case with double plating where fixation failure occurred (Fig. 4). Both fractured plates were medium 2.0 mm plates. Six complications were classified as being non implant-related: significant osteoarthritis in two cases with joint fractures (both revision surgeries initially), improper fracture reduction in three cases, and irritation of the skin over the plate in one case.

Revision surgery was required in cases of fixation failure for five fractures in four patients. These cases included the two dogs with plate failure, one Jack Russell Terrier which...
had screw pullout as a first complication, followed by screw breakage as a second complication, and one cat with an iatrogenic humeral fracture. The revision surgeries were all conducted with the Unilock system, with the exception of the cat with the iatrogenic fracture where an external skeletal fixator was applied. Complications additionally required implant removal in two cases, including a dog with skin irritation over the plate on the radius, and one cat with a humeral fracture stabilised with an intramedullary pin and a 2.4 mm Unilock plate, where the distal screws had not been inserted correctly. This condition was only detected eleven weeks after surgery when fracture healing was already progressed (Fig. 5). All fractures healed eventually.

Nine of the complications occurred in the first half, and four in the second half of the case series. Out of the 12 surgeons using the Unilock system, four surgeons were involved throughout the study period. They treated 51 fractures, in which seven complications were encountered in the first half and two in the second half of the cases.

**Statistical results**

Although only one patient with double plating suffered fixation failure, there was not a significant difference in the occurrence of fixation failure between cases with double plating and cases where only a single plate had been used. Forty-four patients where a single Unilock plate was applied had either no complications (38) or fixation failure (6). In this group, statistical significance was seen for two of the parameters tested. Patients with fixation failure had significantly thinner screws inserted as compared to patients without complications (mean screw to bone diameter ratio of 27.1% versus 32.0%; p = 0.03). Patients with fixation failure had more screws in the main fragment where fewer screws had been inserted in comparison to patients without complications (mean of 3.2 versus 2.6 screws; p = 0.03).

**Discussion**

This retrospective clinical study describes use of the Unilock system for stabilisation of long-bone fractures in small dogs and cats. Instruments and implants were found to be easy to handle. This characteristic has also been described in human mandibular surgery (12, 13). The overall complication rate of 19.7% and the fixation failure rate of 10.6% seem acceptable considering that all cases since introduction of the system at our insti-
plied as a splint and therefore does not pro-
lateral surfaces of the bone.

mm plates can be applied on the medial and
bone size allows. Alternatively, two thick 2.0
humeral and femoral fractures in dogs should
to the elbow and stifle joint. Supracondylar
high implant loads in fractures located close
both cases. Potential reasons for plate failure
in these cases are poor fracture reduction, in-
sufficient stability of the medium 2.0 mm
length was not correlated with fixation failure
in the present study, but in both cases where
plate failure occurred all plate holes had been
filled with screws, which could also have con-
tributed to high implant strain and plate fail-
ure.
Plate length and distance of the plate to the
bone are two factors influencing fixation sta-
bility with the LCP (11). Longer plates pro-
vide more stability because less pullout force
is acting on the screws (14). Although plate
length was not correlated with fixation failure
in the present study, we consider it advisable
to apply relatively long plates. The distance of
the plate to the bone could not be evaluated
due to the retrospective nature of the study.
Results from human studies with the LCP
suggest that the distance between the bone
and the plate should not exceed 2 mm (11,
15). A gap of 1 mm has been shown not to re-
sult in an increased risk of screw failure in
mandibular fractures stabilised with the 2.4
mm Unilock system (12).

With the LCP, inserting up to three mono-
cortical screws increased axial stiffness, and
up to four monocortical screws increased ro-
tational rigidity (11). Recommendations for
the clinical use of the LCP are to insert at least
two screws per fragment that engage at least
corecortices (11,14). It seems from this study
that the Unilock system may also be used with
fewer screws than conventional plates. In this
study, fixation failure cases had significantly
more screws per main fragment (mean 3.2
screws) than those that did not fail (mean 2.6
screws). The numbers of screws and cortices
engaged with screws indicate that bicortical
screws were used more often than monocor-
tical screws in the present study. A biological
advantage of internal fixators is that the
screws can be inserted monocortically (Fig.
1). Holding power of monocortical screws
depends on the presence of healthy cortical
bone and is therefore mainly indicated in the
diaphysis of long bones (4,5,14). In small
bones, care must be taken that the screw tips
do not touch the transcortex during inser-
tion; this has been reported to cause stripping

Fig. 5 Inadequate screw insertion in a cat. A) Preoperative radiograph. Mid-diaphyseal humeral frac-
ture in a cat. B) Radiographs 11 weeks after stabilisation with an intramedullary pin and a 2.4 mm Uni-
lock plate, showing displacement of the plate relative to the bone. C) After plate removal, it was clearly
visible that the three most distal screws had never been inserted into bone. This can go unnoticed at sur-
gery because the screw heads lock inside the plate hole causing a feeling of a tight fit.

Stability and biomechanical behaviour of
an internal fixator is different from that of a
conventional plate. Biomechanical character-
istics of long-bone fracture stabilisation with
internal fixators have been described in
human orthopaedics for the locking com-
pression plate (LCP) (4,11). Similar informa-
tion is not available for the Unilock system, as
it is not used for fracture treatment of long
bones in humans. Although the different in-
ternal fixator systems are likely to have similar
general biomechanical characteristics, the
design of the LCP in comparison to the Unilock
plates may make these two implants behave
differently under load. When the LCP con-
structs were tested to failure, it was usually the
plate that failed (11). There were only two
cases with plate failure in this case series, the
other cases with fixation failure involved
screw breakage, inadequate screw insertion or
screw pull-out, and iatrogenic damage to the
bone. Failure of the LCP plate occurs pre-
dominantly through the dynamic compres-
sion plate (DCP) hole (9,11). The Unilock
plates in this study broke through the narrow
part of the plate between the screw holes in
both cases. Potential reasons for plate failure
in these cases are poor fracture reduction, in-
sufficient stability of the medium 2.0 mm
plates in patients of this body weight, and
high implant loads in fractures located close
to the elbow and stifle joint. Supracondylar
humeral and femoral fractures in dogs should
therefore be stabilised with a 2.4 mm plate if
bone size allows. Alternatively, two thick 2.0
mm plates can be applied on the medial and
lateral surfaces of the bone.

With an internal fixator that is purely ap-
plied as a splint and therefore does not pro-
of the thread and screw loosening in the near cortex in human patients (14). The shortest screws of the Unilock system measure 6 mm in length, which can exceed bone diameter in small patients. Bicortical screws should be inserted in these cases. In metaphyseal and epiphyseal bone with thin cortices, it is also recommended to insert bicortical screws (4, 5, 14). Besides the restrictions of bone size preventing the use of monocortical screws in small patients, it is likely that monocortical screws were not used more often in this case series because of the habit of surgeons to insert bicortical screws.

Iatrogenic fracture or fissuring occurred in two cats with a diaphyseal humeral and femoral fracture respectively. Both cats were older than ten years and had bicortical screws inserted into the diaphysis. Older cats are thought to have brittle bones, which may lead to iatrogenic fissure or fracture. Locking screws are forced into a position perpendicular to the plate during tightening. It is possible that this could result in shear stresses at the transcortex during screw insertion in cases where the drill hole was not orientated perfectly perpendicular to the plate. In the diaphysis of older cats we therefore advise to use monocortical screws if the bone diameter permits.

<table>
<thead>
<tr>
<th>Cats and dogs (up to 13 kg)</th>
<th>Fracture localisation</th>
<th>Fractured bone</th>
<th>Recommendations</th>
</tr>
</thead>
<tbody>
<tr>
<td>Plate size</td>
<td>Diaphysis</td>
<td>Humerus, femur, tibia</td>
<td>Usually a 2.4 mm plate</td>
</tr>
<tr>
<td></td>
<td>Radius</td>
<td>Usually a 2.0 mm plate (medium or thick; with medial plating)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Meta and epiphysis</td>
<td>Humerus, femur</td>
<td>2.4 mm plate if bone size allows</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Radius, tibia</td>
<td>2.0 mm (thick) double plates</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Usually a 2.0 mm plate (medium or thick)</td>
<td></td>
</tr>
<tr>
<td>Plate length</td>
<td>All</td>
<td>All</td>
<td>Relatively long with single plate</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Shorter plates possible with double plates</td>
</tr>
<tr>
<td>Number of cortices per main fragment</td>
<td>All</td>
<td>All</td>
<td>Minimum of four</td>
</tr>
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<td></td>
<td></td>
<td></td>
<td>Maximum of eight</td>
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<tr>
<td></td>
<td></td>
<td></td>
<td>Monocortical screws in diaphysis (especially in older cats)</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Bicortical screws in diaphysis if shortest screw would interfere with transcortex</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Bicortical screws in metaphysis and epiphysis</td>
</tr>
<tr>
<td>Screw size</td>
<td>All</td>
<td>All</td>
<td>30-35% of bone diameter (maximally 40%)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Humerus, femur, tibia</td>
<td>3.0 mm screws with 2.4 plate in larger dogs if bone diameter allows</td>
</tr>
<tr>
<td>Screw positioning</td>
<td>All</td>
<td>All</td>
<td>Leave screw holes empty over the fracture area (number of empty holes depends on fracture configuration and length of plate)</td>
</tr>
</tbody>
</table>

Inadequate screw insertion and/or screw pull-out was observed in two patients, although this should be rare with use of internal fixators. In at least one of the cases this was a technical error; follow-up radiographs showed that the screws had been inadequately inserted and had only engaged the underlying bone partially or not at all (Fig. 5). Inadequate screw insertion is a technical problem that can be encountered with internal fixators. During insertion of locking screws it must be considered that the surgeon is not able to adequately assess how well the screw thread engages the bone, because even if the screw is not engaged at all the surgeon will have a tight-fit feeling when the screw head locks inside the plate hole.

Complications in this study were more frequently seen in humeral fractures, as compared to fractures of other bones. Although humeral fractures, particularly distal humeral fractures, can be difficult to stabilise, an overall complication rate of nearly 40% as seen in this report is unacceptably high. At least three of the complications seen were clearly technical errors (screws not seated in the bone in two cases, selection of too weak a plate in one case), which should be avoidable as our experience with the implant system increases.

Fractures of the distal radius and ulna carry a higher risk for fracture union disorders and other complications in small breed dogs due to a fragile blood supply in the area (16–19). The Unilock system was used to treat 14 fractures of the radius and ulna in dogs with only minor complications and no fracture union disorders occurring. Furthermore, three patients with radial fractures were treated successfully for pre-existing non-unions. An internal fixator seems to be an ideal implant for fractures of the distal radius because it provides stable internal fixation while preserving the fragile blood supply in the fracture area. The same may be true for the treatment of fracture union disorders. All eight cases treated could be brought to healing with a single surgery. In three of the cases, two plates were placed at 90° to the long axis of the bone, which pro-
vided excellent stability (Fig. 3). Complications were also infrequently noted after femoral and tibial fractures. The 2.4 mm plates were found to be a suitable implant to buttress comminuted fractures of the tibia in cats (Fig. 1).

A drawback of the study is that due to its retrospective nature there was a wide range of different fractures and types of repair that were evaluated. Especially the use of ancillary implants such as intramedullary pins might have influenced results. It is likely that the fracture shown in Figure 5 for example would have collapsed without the use of an intramedullary pin. Additionally, the large range of follow-up times does not allow for drawing conclusions regarding time to fracture healing.

An ancillary intramedullary pin was applied in nine fractures. The decision for using a plate-and-rod configuration was mainly based on surgeon’s preference in this study. As with conventional plates, it seems advisable to insert an intramedullary pin to enhance bending stability in comminuted fractures where load-sharing is not achieved. One should consider though that locking screws must be inserted perpendicular to the plate, which can make it difficult to pass the screws around to the intramedullary pin. Also, in very small patients, even the shortest screws can be too long to be inserted without coming into contact with the intramedullary pin. Therefore, the plate and rod configuration should only be used in patients with a bone size that allows insertion of monocortical screws that do not reach the intramedullary pin, and in cases that allow positioning of screws in the wider bone of the meta- and epiphysis where it is easier to pass the intramedullary pin.

Overall it seems that the Unilock system is a suitable implant for stabilisation of long-bone fractures in cats and small dogs. In our opinion it is especially useful for stabilisation of radial and tibial fractures, for stabilisation of comminuted fractures, for double plating of supracondylar fractures of the humerus and femur, and for the treatment of nonunions. Care must be taken to ensure that the screws are inserted correctly into the bone. Bicortical screws should be avoided in the diaphysis of older cats, if bone diameter allows, to avoid iatrogenic fractures or fissions. From the clinical experience gained with the Unilock system and the recommendations of Gautier and Sommer (14) for use of locking plates in human surgery, we currently suggest using the Unilock system as summarised in Table 1.

References
