Use of T-plates for the stabilisation of supracotyloid ilial fractures in 18 cats and five dogs

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Summary
The use of the AO (Arbeitgemeinschaft für Osteosynthesefragen) veterinary T-plates (1.5/2 mm and 2.7/3.5 mm) for stabilisation of supracotyloid ilial fractures in 18 cats and five dogs was evaluated in a retrospective study. The distal fragment from the coxofemoral joint ranged from 0.5 cm to 1 cm with a mean distance of 0.85 cm. Twenty out of 23 (87%) ilial fractures healed in original alignment. Three out of 23 (13%) animals had two loosened screws of the distal fragment with fracture malunion and minor medial displacement of the acetabular fragment. Screw or plate breakage was not observed and the implants were not removed. The clinical result was 'excellent' for 18 animals (78%), 'good' for four animals (17%), and 'poor' for one animal (5%). The use of T-plates permits good correction of supracotyloid fractures with minimal approach and minimizes post-operative complications.

Keywords
T-plates, supracotyloid ilial fractures, cat, dog

Introduction
Pelvic fractures are among the most common injuries seen in veterinary practice, comprising 20 to 30% of all fractures, of which 18 to 46% are ilial fractures (1–5). Conservative management may suffice when instability and displacement are minimal (2–4). In contrast, with severe instability causing pelvic canal obstruction or nerve entrapment, bilateral injury or acetabular involvement, the surgery is necessary for reduction and stabilization of the fracture.

Repair of the ilial body is the most common surgical procedure performed for pelvic fractures. A variety of different techniques have been reported for the fixation of iliac fractures: lateral plate (6), ventral interfragmentary screws (7–9), reconstruction plates (10), K-wire and interfragmentary wires (2), a combination of lag screws, pins, orthopaedic wires and bone plates (5). While the tension surface of the ilium has been shown to be ventromedial (8, 9 ), the lateral plate fixation is the most commonly used technique (1–6, 11).

When the level of the fracture is at the 25 percentile of the ilial length, the distal fragment close to the acetabulum is therefore very small, which can make classical fixation difficult. In this study, for convenience, we will use the term ‘supracotyloid’ fractures in order to define this type of fractures located on the distal ilial fragment (Fig. 1). This is an extrapolation from ‘supracondylar’ humeral and femoral fractures.

Anatomically, it lies from the cranial part of the acetabular rim to the Greater Sciatic Notch and is centered on the tuberosity for Rectus Femoris. In order to fulfil the objectives of trying to engage screws in at least four cortices in the distal fragment with a minimal approach, we used a ‘T’-shaped plate. Given the very narrow width and the thin cortices of the ilium, especially in cats, the AO Veterinary T-plates seem to be a suitable plate that is currently available.

This article is a retrospective study of the use of the AO Veterinary T-plates (mini T-plates 1.5/2 mm and 2.7/3.5 T-Plates) (Fig. 2) in a series of 18 cats and five dogs with distal ilial (‘supracotyloid’) fractures.

Material and methods
The records, surgery reports and radiographs of all of the cases between 2001 and 2005 in which T-plates was used were reviewed. The criteria for inclusion in the study were fracture of the distal ilium (supracotyloid), and repair with open reduction and internal fixation utilising the T-plate (AO Veterinary mini T-plate 1.5/2 mm and AO Veterinary 2.7/3.5 mm T-plate) as the sole method of fixation (Fig. 2).

The history, signalment, weight, initiating trauma, description of the pelvic fractures and other concomitant fractures or systemic lesions, have been documented. The medical records, radiographs and surgical reports were reviewed for details regarding the configuration of the ilial fracture (the distance between the ilial fracture line and the cranial acetabular rim was measured) the type of implants used to stabilise the fracture and post-operative complications.

The animals were placed in lateral recumbency. A standard craniolateral approach of the ilium and hip was used (12). The gluteal musculature was elevated off the lateral face of the ilium using a periosteal elevator. Sharp dissection of the ventral origin of the gluteal muscles on the wing of the ilium allowed greater retraction and greater exposure of the fracture site. The
joint capsule was incised cranially to the acetabular rim to have a landmark before positioning the plate. The fracture fragments were identified and reduced with the aid of pointed bone reduction forceps attached to the greater trochanter and bone handling forceps onto the proximal ilial fragment. Levering was useful and accomplished with a periosteal elevator or a Hohman retractor slipped between the two fracture segments. Care had to be taken during levering so as not to damage the sciatic nerve. In some cases, we grasped the cranial part of the acetabulum with a pointed bone reduction forceps, thus helping reduction (2–6).

The two distal screws were applied first; they were angled slightly cranially in order to avoid the acetabulum. The rest of the screws were then placed with one or two of the proximal screws in the loaded position, giving compression across the fracture site, in some cases. The proximal part of the plate, which was previously contoured, can be used as a lever in order to help reduction. The joint capsule was closed with monofilament absorbable suture material, in simple horizontal mattress pattern, if adequate joint capsule was present in both sides.

The patients were reviewed in the referral institutions at least twice (two and six weeks post-operatively) for follow-up physical and radiographic evaluation.

Long-term follow-up was carried out either by means of clinical reviewing and follow-up radiographs, or by means of owner telephone questionnaire.

Function of the affected limb was graded using the following classification: ‘excellent’ (return to complete normal function without any detectable gait abnormality); ‘good’ (very mild intermittent lameness after prolonged or vigorous exercise); ‘fair’ (frequent mild to moderate weight bearing lameness); ‘poor’ (permanent moderate to severe gait abnormality). A retrospective evaluation of long-term results also included the elicitation of pain or crepitus on manipulation of the coxofemoral joint, subjective assessment of coxofemoral joint range of motion. Obviously, the presence of any long-term complications, such as swelling, implant failure, muscle atrophy or neurological deficit, should be noted.

Post-operative and follow-up radiographs were reviewed by the authors.

Fracture reduction on immediate post-operative radiographs was graded into three different categories and was based on ventrodorsal and lateral views: ‘excellent’ (over 80% of bone surface apposition); ‘good’ (between 50 and 80% of bone surface apposition); and ‘poor’ (less than 50% of bone surface apposition). We also screened for technical errors, including: malposition of distal screws (penetration of the acetabulum); overlapping between T-plate and cranial rim of the acetabulum risking coxofemoral joint impingement; oversized screws, plate apposition, pelvic collapse.

Radiographs at the longest available follow-up examination (greater than six weeks) were assessed for healing of the fracture, implant stability, complications associated with fracture fixation and osteoarthritis of the coxofemoral joint. The fracture was considered to be healed if the fracture callus or bone had bridged the fracture line on all follow-up radiographic projections. Any changes in implant or fragment position were noted and coxofemoral osteoarthritis was diagnosed if radiographic changes of periarticular osteophytes formation or remodelling of acetabulum and femoral head were seen.

**Results**

In five dogs and 18 cats, 23 medially displaced comminuted fractures of the distal part of the ilium at the level of the caudal aspect of the sacro-iliac joint were repaired with T-plates.

Fractures repairs were performed by the authors.

The distance from the distal fracture line to the cranial acetabulum, measured retrospectively on the pre-operative radiographs, ranged from 0.5 cm to 1.1 cm with a mean distance of 0.85 cm (0.78 cm for the cats and 0.92 cm for the dogs).

Six animals (Cases #2, #8, #9, #20, #21, #22) had a large splinter (>1 cm) (Fig. 1).

The weight of the animals ranged from 2.7 kg to 22 kg with a mean weight of 5.33 kg. The mean age at the time of fracture was...
Supra-cotyloid fractures stabilised by T-plates

3.3 years (six months to 12 years). All of the animals had been hit by car, and all had sustained concomitant ischial fractures, and pubic fractures. Seven animals had sustained unilateral sacro-iliac luxations (Cases #1, #4, #11, #12, #14, #20, #21) (Fig. 3A) in addition to their ilial fractures. Six animals had concomitant fractures in long bones (Cases #3, #6, #9, #12, #13, #17). Two dogs had a hind limb proprioceptive deficit before surgery which resolved for one dog (Case #21) by the second postoperative week. The second dog was lame at six weeks post-operatively with a minor neurological deficit, but was not rechecked afterwards because the owners moved (Case #18).

All of the animals were clinically re-examined at two weeks post-operatively and radiographed at six weeks post-operatively but three of the animals were not re-examined afterwards (Cases #4, #5, #18).

Twelve animals were rechecked either by the surgeon or by the referring veterinarians; and we performed a long-term radiographic evaluation (more than six weeks post-operatively) (Cases #1, #3, #8, #9, #11, #12, #13, #16, #17, #20, #21, #23). In addition, eight animals were evaluated by means of owner telephone questionnaire, and three animals were lost for the long-term follow-up (Cases #4, #5, #18). Mean recent follow-up period when the animals were re-examined or the owners were contacted was 19.5 months with a range of two to 50 months.

Nineteen ilial fractures were stabilized with 1.5/2 mm T-plates and four with 2.7/3.5 mm T-plates (Cases #11, #18, #21, #22). The screws were placed in all screw holes in 18 animals and 5/6 holes in five animals because of comminution (Cases #8, #10, #11, #19, #21) (Fig. 3B).

‘Excellent’ reduction was achieved in three animals (Cases #1, #3, #14) (Fig. 4A) and ‘good’ reduction was achieved in 15 animals, despite fracture comminution. ‘Poor’ reduction was observed in six animals because of loss of bone due to a large splint (Cases #2, #8, #9, #20, #21, #22).

Twenty out of 23 ilial fractures healed in the original alignment. Loose screws without fracture malignment were evident on radiographic follow-up in a single cat (Case #3) (Fig. 4A) because it was a proximal screw. Three cats (Cases #6, #9, #16) had two loosened screws of the distal fragment with fracture malunion and medial displacement of the right acetabular fragment (Fig. 4B). Neither screw nor plate breakage was observed and the implants were not removed.

Minor osteoarthritits of the femoral head was observed in two cats (Cases #3, #20) but additional articular surgery was not needed.

At most recent follow-up, two animals (Cases #9, #12) were assessed as lame by clinician assessment. Furthermore, two animals (Cases #4, #5) were lame at the first follow-up (six weeks post-operatively) but were not reevaluated afterwards. All lamenesses were grade 1, except for the dog with the neurological deficit (lameness grade III, Case #18).

The clinical result was ‘excellent’ for 18 animals (Fig. 5B, C, D), ‘good’ for four animals (4, 5, 9, 12) and ‘poor’ for one animal (18) (Table 1).

Discussion

Transverse and comminuted fractures of the ilium are less common than oblique fractures. In a recent radiographic retrospective study (1) 14% of the ilial fractures were transverse fractures, 16% were comminuted fractures, and 70% were oblique fractures. This is in agreement with the findings of previous studies (3, 4, 6, 7). They are frequently associated with sacroiliac luxations and concomitant long bone fractures (12/23 animals in our study).

Bone plate stabilisation of ilial fractures is the most widely used method of repair. Bone plates provide excellent stability for fracture fixation and generally allow early controlled weightbearing by the animal. The success rate for fracture healing after ilial plating is excellent (2–6, 11). To attach the
bone plate firmly, three screws should ideally be placed through the plate on both sides of the fracture. But in many ilial fractures it is possible to place just two screws on one side of the fracture and three screws on the other side due to the intrinsic stability afforded by these bones by the soft-tissue attachments (2, 4, 5).

In fractures with a very short end fragment (less than 1 cm long), it is difficult to follow these plate application guidelines, such as engagement of at least 4, but preferably 6, cortices on either side of the fracture. T-plating was used in order to increase the amount of engaged cortices per fragment. In veterinary orthopaedics, T-plates have been applied for pancarpal arthrodesis (2), distal radial fracture (13), scapular fracture (14) and distal radial osteotomies (15, 16) or closing wedge osteotomies (17).

The veterinary 2.7/3.5 mm ASIF T-plate was introduced in 1986 and the AO 1.5/2 mm mini T-plate in 1987. Because the 2.7/3.5 mm AO T-plate can accommodate 2.7 mm as well as 3.5 mm cortical screws, it may be used in a wider range of bone sizes (animal sizes) as compared with either the 2.7 mm or 3.5 mm DCP. Similarly, the AO 1.5/2 mm veterinary mini T-plate can be used in a wider range of bone sizes (animal sizes), as compared with the 2 mm DCP.

Concerning the AO 1.5/2 mm veterinary mini T-plate, its small size and close approximation of the two distal screw holes enables at least two screws to be placed in small distal fragments (up to 0.5 cm long in some cases of our study) which would not be possible using a conventional straight dynamic compression plate (DCP). The plate is narrow but it is 0.5 mm thicker than the corresponding straight-6-hole DCP, making it ideal for use in cats or small dogs. The design of this plate gives excellent stability and also allows compression to be achieved across the fracture site, thus promoting bone healing.

The 2.7/3.5 mm AO T-plate, whilst it is thinner (2 mm deep) than a comparable length 2.7 mm (2.5 mm deep) or 3.5 mm DCP (3.2 and 3.6 mm thickness), it has been shown to have no difference in axial stiffness when used to stabilize a distal radial osteotomy (16).

The biomechanical values of T-plates have not yet been examined for iliac frac-
Table 1  Clinical data of 23 animals with T-plate application to pelvic fractures.

<table>
<thead>
<tr>
<th>Case N°</th>
<th>Breed, Sex, Age, Weight</th>
<th>Fractures</th>
<th>Concomitant Problems</th>
<th>Fracture Repair Technique</th>
<th>Radiographic Recheck</th>
<th>Clinical Recheck</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Cat, M, 3 y, 5 kg</td>
<td>Right Ilium, Left Saccroiliac lux</td>
<td></td>
<td>T-Plate 1.5/2 mm, 6 screws 2 mm</td>
<td>46 mon, fracture healed</td>
<td>46 mon, no lameness</td>
</tr>
<tr>
<td>2</td>
<td>Cat, M, 4 y, 4.2 kg</td>
<td>Right Ilium, 1 large splinter</td>
<td></td>
<td>T-Plate 1.5/2 mm, 6 screws 2 mm</td>
<td>No change in implant at 6 weeks</td>
<td>48 mon, no lameness</td>
</tr>
<tr>
<td>3</td>
<td>Cat, F, 2 y, 3.5 kg</td>
<td>Left Ilium</td>
<td>Left Tibial fracture 8 holes BCP</td>
<td>T-Plate 1.5/2 mm, 5 screws 2 mm, Lag screw 2 mm</td>
<td>No change in implant at 6 weeks</td>
<td>50 mon, no lameness</td>
</tr>
<tr>
<td>4</td>
<td>Cat, M, 1.5 y, 3.1 kg</td>
<td>Right Ilium comminuted Right Saccroiliac lux.</td>
<td></td>
<td>T-Plate 1.5/2 mm, 5 screws 2 mm, Lag screw 2 mm</td>
<td>No change in implant at 6 weeks</td>
<td>6 weeks, Grade I lameness. Lost</td>
</tr>
<tr>
<td>5</td>
<td>Cat, M, 3.5 y, 2.9 kg</td>
<td>Left Ilium comminuted</td>
<td></td>
<td>T-Plate 1.5/2 mm, 6 screws 2 mm</td>
<td>No change in implant at 6 weeks</td>
<td>6 weeks, Grade I lameness. Lost</td>
</tr>
<tr>
<td>6</td>
<td>Cat, M, 6 mon 3 kg</td>
<td>Left Ilium comminuted</td>
<td>Left tibial fracture Centromedullary Pin</td>
<td>T-Plate 1.5/2 mm, 6 screws 2 mm</td>
<td>Distal 2 screws loose, fracture healed, minor pelvic narrowing</td>
<td>12 mon, no lameness O.T.</td>
</tr>
<tr>
<td>7</td>
<td>Cat, F, 4 y, 4 kg</td>
<td>Left Ilium, oblique comminuted</td>
<td></td>
<td>T-Plate 1.5/2 mm, 6 screws 2 mm</td>
<td>No change in implant</td>
<td>3 mon, no lameness O.T.</td>
</tr>
<tr>
<td>8</td>
<td>Cat, M, 1 y, 3.7 kg</td>
<td>Left Ilium</td>
<td></td>
<td>T-Plate 1.5/2 mm, 5 screws 2 mm</td>
<td>No change in implant at 4 mon, Delayed union</td>
<td>4 mon, no lameness, Euthanised: Acute Renal F.</td>
</tr>
<tr>
<td>9</td>
<td>Cat, M, 4 y, 3.5 kg</td>
<td>Left Ilium</td>
<td>Pneumothorax, Left lat. Humeral condyle fracture- Lag screw + pin</td>
<td>T-Plate 1.5/2 mm, 6 screws 2 mm</td>
<td>2 mon Distal 2 screws loose, fracture healed, Minor pelvic narrowing</td>
<td>2 mon, Grade I lameness</td>
</tr>
<tr>
<td>10</td>
<td>Cat, M, 1 y, 2.9 kg</td>
<td>Left Ilium comminuted</td>
<td></td>
<td>T-Plate 1.5/2 mm 5 screws</td>
<td>No change in implant at 6 weeks</td>
<td>18 mon, no lameness O.T.</td>
</tr>
<tr>
<td>11</td>
<td>Dachshund, M, 5 y, 10 kg</td>
<td>Left Ilium comminuted</td>
<td>Right Saccro-iliac fracture + luxation Lag screw, Transiliac pin</td>
<td>T-Plate 2.7/3.5 mm, 5 screws 2.7 mm</td>
<td>No change in implant, fracture healed</td>
<td>10 mon, no lameness</td>
</tr>
<tr>
<td>12</td>
<td>Cat, F, 2 y, 3.8 kg</td>
<td>Right Ilium comminuted</td>
<td>Left Saccro-iliac luxation (lag screw) + calcaneal fracture, (tension band wire)</td>
<td>T-Plate 1.5/2 mm, 6 screws 2 mm</td>
<td>10 mon No change in implant, fracture healed</td>
<td>26 mon, Grad I lameness</td>
</tr>
<tr>
<td>13</td>
<td>Cat, F, 8 y, 4.2 kg</td>
<td>Rt Ilium comminuted</td>
<td>Right Olecranon fracture (tension band wire)</td>
<td>T-Plate 1.5/2 mm, 6 screws 1.5/2 mm</td>
<td>26 mon No change in implant, fracture healed</td>
<td>24 mon, no lameness</td>
</tr>
<tr>
<td>14</td>
<td>Cat, F, 6 y, 3.5 kg</td>
<td>Left Ilium + Left Saccroiliac luxation</td>
<td></td>
<td>T-Plate 1.5/2 mm, 5 screws 2 mm + 1 lag screw into the plate</td>
<td>24 mon Fracture healed. No change in implant</td>
<td>28 mon, no lameness O.T.</td>
</tr>
<tr>
<td>15</td>
<td>Cat, M, 3 y, 4 kg</td>
<td>Right Ilium comminuted</td>
<td></td>
<td>T-Plate 1.5/2 mm, 6 screws 2 mm</td>
<td>No change in implant, fracture healed</td>
<td>25 mon, no lameness O.T.</td>
</tr>
<tr>
<td>16</td>
<td>Cat, F, 1 y, 3.3 kg</td>
<td>LT IIlium comminuted</td>
<td></td>
<td>T-Plate 1.5/2 mm, 6 screws 2 mm</td>
<td>19 mon Distal 2 screws loose, fracture healed, minor pelvic narrowing</td>
<td>19 mon, no lameness</td>
</tr>
<tr>
<td>17</td>
<td>Cat, F, 6 mon 2.7 kg</td>
<td>Right Ilium comminuted</td>
<td>Right Tibial fracture (external fixators)</td>
<td>T-Plate 1.5/2 mm, 6 screws 2 mm</td>
<td>16 mon Fracture healed. No change in implant</td>
<td>16 mon, no lameness</td>
</tr>
<tr>
<td>18</td>
<td>Spaniel, M, 1 yr 22kg</td>
<td>Left Ilium comminuted</td>
<td>Pneumothorax, left proprioceptive deficit</td>
<td>T-Plate 2.7/3 mm, 6 screws 3.5 mm</td>
<td>No change in implant</td>
<td>6 weeks, Grade III lameness, Neuro deficit, Lost</td>
</tr>
<tr>
<td>19</td>
<td>Cat, F, 12 y, 4 kg</td>
<td>RT Ilium, oblique comminuted</td>
<td></td>
<td>T-Plate 1.5/2 mm, 5 screws 2 mm</td>
<td>No change in implant, fracture healed</td>
<td>12 mon, no lameness O.T.</td>
</tr>
<tr>
<td>20</td>
<td>Cat, M, 2 y, 2.9 kg</td>
<td>Left Ilium</td>
<td>Right Saccroiliac luxation (2 lag screws) + coccyeal luxation (tail amputation)</td>
<td>T-Plate 1.5/2 mm, 6 screws 2 mm</td>
<td>10 mon Fracture healed. No change in implant, Minor osteoarthritis</td>
<td>10 mon, no lameness</td>
</tr>
<tr>
<td>21</td>
<td>Kings Charles, F, 2 y, 11 kg</td>
<td>Left Ilium</td>
<td>Right Ilium comminuted Left Saccro-iliac luxation (2 lag screws)</td>
<td>T-Plate 2.7/3.5 mm, 5 screws 2.7 mm</td>
<td>15 mon Fracture healed. No change in implant</td>
<td>15 mon, no lameness</td>
</tr>
<tr>
<td>22</td>
<td>Lhasa Apso, M, 2 y, 9 kg</td>
<td>Left Ilium</td>
<td>Left Ilium comminuted Left Ilium + Saccroiliac luxation</td>
<td>T-Plate 2.7/3.5 mm, 6 screws 2.7 mm</td>
<td>No change in implant, fracture healed</td>
<td>19 mon, no lameness O.T.</td>
</tr>
<tr>
<td>23</td>
<td>York, M, 7 y, 6.5 kg</td>
<td>Right Ilium comminuted</td>
<td></td>
<td>T-Plate 1.5/2 mm, 6 screws 2 mm</td>
<td>3 mon Fracture healed. No change in implant</td>
<td>3 mon, no lameness</td>
</tr>
</tbody>
</table>

O.T. = Long-term follow-up reviewed by means of owner telephone questionnaire. Lost = The animals were no longer reviewed after six weeks post-operatively.
tures. But as the 2.7/3.5 mm T-plate are thinner than DCP the use of stacked-T-plates has been recommended (14) to avoid bending forces, in order to increase the rigidity and strength of the fracture repair, especially for large dogs (>20 kg). We did not use any stacked-T-plates because we had only one dog that weighed more than 20 kg (Case #18). We used a single T-plate 2.7/3.5 mm without any problems until six weeks follow-up, but we can not draw any conclusions since the follow-up period was too short.

The AO/ASIF T-plates are available in 316 L stainless steel and in different sizes, ranging from 2 mm 2 holes, to 4.5 mm 12 holes. Some of them are available with either oblique or right angles (14, 18).

T-mini plates (1.5/2 mm) have been recommended for the repair of ilial fractures in dogs and cats weighing up to 10 kg (19).

The 2.7 mm T-plate was not used because of its weakness (1 mm deep). The 2.7/3.5 T-plate was used instead with 2.7 mm screws for dogs weighing between 8 to 15 kg.

In the cases reported herein, T-plating was performed because it was obvious during the surgery that the short bone fragment close to the acetabulum would not have allowed enough screws to achieve reliable implant fixation with a DCP plate, and that the configuration of the fractures did not allow reliable application of most other fixation devices (lag screws, K–wire and interfragmentary wires...). An alternative to the T-plate is the use of a reconstruction plate overlapping the cranio-dorsal rim of the acetabulum, but this technique is more aggressive and time-consuming (osteotomy of greater trochanter, sciatic nerve retraction) and the fixation device is more difficult to apply (it is difficult to precisely contour a reconstruction plate to fit a bony pelvis (2, 5, 10).

Another alternative to the T-Plate is a composite fixation technique (a combination of Kirschner wires, orthopaedic wire, lag screws and polymethylmethacrylate), which was described for acetabular fractures repair (5, 20, 21) and combined ilial-acetabular fracture repair (5).This composite fixation technique is advantageous because it does not require the surgeon to contour a bone plate to the exact shape of the bone and results in more accurate reduction of the fracture. The biomechanical properties of the composite fixation technique are similar to properties of acetabular bone plate fixation and could be used for supracotyloid fractures. However, further studies are warranted because the biomechanics of the acetabulum and the ilium are likely to be different.

The major advantage of T-plate fixation, as indicated in this study, is the low number of complications: osteomyelitis, fracture malunion, implant breakage, decrease range of motion of the hip, post-operative sciatic nerve deficit were all not observed. Furthermore, none of the animals in this study required an additional treatment or surgical procedure. Implant removal, as well as femoral head and neck excision were also not necessary.

Previously reported complications for combined ilial and acetabular fractures include: implants failure (broken plates), fracture malunion, lameness with mini-plates application (19) or decreased range of motion of the hip, lameness, additional surgery needed, and lamenes with the use of reconstruction plates (10).

Other advantages of a T-plate fixation for ilial supracotyloid fractures include: the lack of aftercare required by the owner, rapid bone healing, and the need for only one surgical procedure.

The loosening of miniscrews is the most common complication. In this study, this complication occurred in only four cases (in the distal fragment in three cases and in the proximal fragment for one case), but this did not have a negative effect on the clinical result (no lameness was observed, minor pelvic canal narrowing without any constipation).

Screw loosening occurred in six of 13 ilial or acetabular fractures repaired with 2 mm implants (19). Mini screw (2 mm) loosening in 12 dogs weighing 13 and 16 kg was reported in a study of 14 dogs with acetabular fractures repaired with acetabular plates (22) and implant loosening or breakage occurred in eight of 13 2.0 mm implants (seven of 10 animals), which resulted in malunion of three fractures (19).

The loosening of all of the screws on one side of a fracture line could indicate an over-load of the screw fixation or it could be the result of improper placement of one or more of the screws. No notations of stripped screws were made in the surgical records in these animals. The incidence of screw loosening seems to be influenced by the presence of concomitant fractures (animals with concomitant fractures may place more weight on each fracture repair thus increasing stress on the implant and accelerating implant loosening) and by the young age of animals (2 mm spongiosa screws are not available to repair the pelvis of young cats or young small dogs). However, screw loosening did not appear to be influenced by the size of the distal ilial fragment which ranged from 0.5 cm (Case #6) to 1 cm (Case #9), which represents one of the largest sizes in this study.

Thin cortices of the ilium and acetabulum in small dogs and cats require the correct choice of screw size in order to maximize screw anchorage in the bone (2, 18). Loose 2 mm screws were reported in previous reports with mini implant repair of ilial and acetabular fractures, and the authors pointed out the need for extreme precision for drilling and tapping the 2 mm screws (4, 7, 10, 19). We also stressed the need for extreme care when placing and tapping the 2 mm screws to eliminate technical errors, especially when you can not engage 6 cortices on either side of the fracture line. We recommend engaging the distal screws in the redundant tuberosity fo Rectus Femoris muscle in a divergent way.

The 2.7 mm screws are stronger than the mini-implants (1.5 and 2 mm screws), but bone size in animals weighing less than 8 kg often precludes the use of 2.7 implants.

Since we did not observe any implant breakage in this study, we recommended the use of AO Veterinary mini-T-plate 1.5/2 mm for the repair of ilial supracotyloid fractures in cats and dogs weighing up to 8 kg, then the use of T-plate 2.7/3.5 mm associated with 2.7 mm screws for dogs weighing up to 15 kg and the use of T-plate 2.7/3.5 mm associated with 3.5 mm screws for dogs weighing more than 15 kg. As previously mentioned, we do not have any experience with stacked-T-plate in our study, but one of the authors recommended the use of stack
ed-T-plate 2.7/3.5 mm plates for dogs weighing more than 20 kg (14).

Screw loosening, fracture healing and the clinical outcome did not seem to be influenced by the signalment, weight or characteristic of the fracture. All of the fractures healed despite implant loosening, although four fracture repairs resulted in lameness. For two patients, post-operative lameness was attributed to fracture malunion or delayed union due to the short follow-up period (six weeks for Cases #4, #5). For a further two patients, post-operative lameness was attributed to comitant problems (neurological problem for Case #18 and comitant calcaneal fracture for Case #12).

**Conclusion**

The use of a T-plates in 18 cats and five dogs permits good correction of iliac suprapectyloid fractures with minimal approach, good return to function and also minimizes post-operative complications.

T-plates have been used to overcome the limited number of points of fixation in the distal ilial fragment just cranial to the acetabulum. The T-plates seem to be an accepted form of stabilisation for iliac suprapectyloid fractures.

However, on the basis of the incidence of screw loosening in this retrospective study, in the future biomechanical studies on T-plates should be performed which can permit the production of various T-plates (design, number of holes, thickness, etc.).

**References**


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