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Bone Anchor Set

Highest pullout strength for precise, safe ligament and tendon reconstruction

With Specialist Article

by Dr. Daniel Koch & Dr. Detlef Apelt

BONE ANCHOR SET – FEATURES

Highest pullout strength for precise, safe ligament and tendon reconstruction

The Bone Anchor Set is an innovative, screw-thread-based anchor system for veterinary ligament and tendon reconstruction in small animals. It impresses with maximum stability, precise placement, and a sophisticated design for safe application, specifically adapted to different animal sizes, from cats to large dog breeds.

Features

- High pullout strength: Significantly exceeds traditional hook anchors and other anchor systems
- Titanium material: Ensures high biocompatibility and infection resistance
- Self-drilling & self-tapping: Easy handling after initial perforation with a KIRSCHNER wire
- Versatile screw sizes: Diameters from Ø 1.3 mm to Ø 2.8 mm, available in various lengths
- Double-head drilling: Allows the insertion of multiple sutures through the same anchor head – pre- or intraoperatively using the threading aid
- Rounded head design: Minimizes the risk of foreign body reactions – in contrast to conventional, classic screw heads with washers

Areas of application

Ideal for collateral ligament replacement in:

- Carpus
- Elbow
- Tarsus
- Knee

Benefits at a glance

- Precise anchorage: Precise fixation in the metaphyseal position is possible
- At least two sutures are threaded through the anchor head Cross-shaped thread can be inserted through the double eyelet in the anchor head
- Free choice of monofilament or polyfilament thread: the thread thickness is based on the animal size, tissue type, and location
- High stability whilst minimally invasive

BONE ANCHOR SET – ITEM LIST

Bone Anchor Set		
Item no.	**Description**	**Quantity**
198200	**Complete set, consisting of:**	
198201	Bone anchor module with cover (dimensions in mm: 120 × 80 × 32) – without screws and instruments	1
198202	Handle for screwdriver, HEX 2.5 (length: 95 mm, black)	1
198203	Screwdriver blade, HEX 2.5 (length: 68 mm)	1
198204	Thread puller	1
198205	5 KIRSCHNER drill wires Ø 1.2 × 100 mm, trocar/blunt	5
198210	Bone anchor screw Ø 1.6 mm × 7 mm, light blue	2
198211	Bone anchor screw Ø 1.6 mm × 9 mm, light blue	2
198212	Bone anchor screw Ø 1.6 mm × 11 mm, light blue	2
198215	Bone anchor screw Ø 2.0 mm × 7 mm, gold	2

Bone Anchor Set		
Item no.	**Description**	**Quantity**
198216	Bone anchor screw Ø 2.0 mm × 9 mm, gold	2
198217	Bone anchor screw Ø 2.0 mm × 11 mm, gold	2
198220	Bone anchor screw Ø 2.4 mm × 9 mm, magenta	2
198221	Bone anchor screw Ø 2.4 mm × 11 mm, magenta	2
198222	Bone anchor screw Ø 2.4 mm × 13 mm, magenta	2
198225	Bone anchor screw Ø 2.8 mm × 9 mm, blue	2
198226	Bone anchor screw Ø 2.8 mm × 11 mm, blue	2
198227	Bone anchor screw Ø 2.8 mm × 13 mm, blue	2
198230	Bone anchor screw Ø 1.3 mm × 5 mm, green	2
198231	Bone anchor screw Ø 1.3 mm × 6 mm, green	2
198232	Bone anchor screw Ø 1.3 mm × 7 mm, green	2

Use of double-headed drilled bone anchors in small animal orthopaedics

A new bone anchor system with a double-drilled screw head and a special insertion aid for a polyester thread was used in three cases. It was shown that the bone anchors helped to achieve rapid initial stability of the ligament replacement. The possibility of screwing in the bone anchors with the suture already inserted also opens up the use of this joint stabilisation technique in surgically deep tissues, such as the medial epicondyle of the humerus, and many other indicated areas.

Introduction

A variety of techniques are available for the reconstruction of ligaments and tendons in small animal orthopaedics. Primary ligament or tendon fixation using sutures usually leads to an unsatisfactory result because, despite sophisticated suture guidance in the ligament or tendon stump (Bunnell technique, three-loop-pulley pattern, locking loop), no sufficient healing of the tissue is achieved and joint instability or tendon looseness is the result (Berg and Egger, 1986; Kowaleski et al., 2012; Egger, 2014). The appositional suture must therefore be protected with an additional measure. Synthetic substitute materials are suitable for this purpose, usually made of non-absorbable polyester, polypropylene or the long-term absorbable polydioxanone, which remain functional via tunnels in the bone, on or over screw heads or in the connective tissue until the tendon or ligament has healed (Egger, 2014). For certain tendons (patellar ligament, heel tendon cord), temporary transarticular immobilisation using external fixation must also be used. Recently, so-called bone wheeling has also been introduced (De Wild et al., 2023), which promises improved anchoring of the screw by means of polymer pressed into the bone, especially in osteoporotic bone. Bone anchors are primarily used in human medicine. Anchors based on screw threads have become established because they are more favourable than the hook anchors and have the highest pull-out resistance (Visscher et al., 2019). In veterinary orthopaedics, regular bone or plate screws with large heads, whose surfaces were enlarged with washers, served as the first anchors. The sutures were passed around the screw heads (Kowaleski et al., 2012; Egger, 2014). This was soon followed by special bone anchors with smaller and cannulated heads or specially shaped bone hooks (Balara et al., 2004; Logothetou et al., 2022). A bone anchor system (Eickemeyer Medizintechnik für Tierärzte KG, Tuttlingen) with a double head bore and special threading aid for the suture (Figs. 1 and 2) is now also available and has been clinically tested in selected cases.

1

Fig. 1: The new bone anchor system with various screw sizes and special instruments.

2

Fig. 2: A threading aid (top) and a screwdriver blade with a recess (bottom) for holding the already threaded suture were developed to optimally screw in the anchor with a double-headed hole (centre).

Case reports

Rupture of the lateral collateral and the anterior cruciate ligament in the knee of a cat (detailed description of the technique)

A five-year-old female European shorthair cat weighing 3.5 kg was presented with lameness of the left hind limb. Severe swelling, tenderness, a positive drawer phenomenon and lateral instability of the stifle joint on varus stress testing were noted. X-rays showed an increased soft tissue shadow around and in the stifle joint, a medial displacement of the tibia and a reduced joint space (Fig. 3). The diagnosis was: anterior cruciate ligament tear and lateral collateral ligament tear in the left stifle joint.

For surgical treatment, the knee joint was opened via a parapatellar lateral approach. Remnants of the anterior cruciate ligament and the torn caudal horn of the medial meniscus were both removed, the caudal cruciate ligament was intact. The origin and attachment of the lateral collateral ligament on the distal femur and proximal fibula were exposed and the collateral ligament remnants identified. The proximal bone anchor was placed on the distal femur at the point where the lateral collateral ligament originates.

With the help of a Kirschner nail (Ø 1.2 mm), the bone cortex was perforated at this point, then the bone anchor (Ø 1.6 mm, length 9 mm) was screwed in to slightly more than half its length. The ligament substitute (polypropylene, USP 0) was threaded in using the threading aid. For this purpose, the anchor head had to be positioned slightly above the level of the soft tissue or the bone cortex. Once the ligament replacement had been threaded in, the bone anchor could be screwed in to the appropriate level using the special screwdriver. For the distal bone anchor, located at the level of the proximal tibia, a point was selected that was closest to the lateral collateral ligament, directly proximal to the head of the fibula and provided sufficient bone to hold the bone anchor in place.

The bone cortex was perforated on the tibial plateau with the Kirschner nail and the anchor (Ø 1.6 mm, length 9 mm) was screwed into the hole. The replacement ligament for the collateral ligament was threaded in here as described above. The thread was laid in a figure 8 configuration and knotted (Fig. 4 and 5).

For the replacement of the cranial cruciate ligament, a bone tunnel was drilled from medial to lateral at the proximal tibia, around 4 mm distal to the joint level and slightly cranial to the front edge of the menisci using a Kirschner nail (Ø 1.6 mm). Due to the anchor system being double-headed, a further ligament replacement suture (polypropylene, USP 0) could be inserted at the proximal bone anchor, pulled through the tibial tunnel and knotted (Fig. 6). The joint capsule was sutured with individual halves. The lateral muscle fascia was tightened and the wound closed. X-rays were taken after the procedure (Fig. 7) and a modified Robert-Jones bandage was applied.

The postoperative check-up of the cat after five weeks still showed a slight lameness of the supporting leg. Manual examination of the lateral and anterior cruciate ligaments did not reveal any instability. The patient was referred to physiotherapy to increase its muscle strength.

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Fig. 3: Preoperative X-ray images of the first case. There is a subluxation (ML image) and medial displacement of the tibia (AP image) with subsequent medial dislocation of the patella and a knee joint effusion.

Fig. 4: The lateral ligament replacement thread is inserted into the the threading aid which is subsequently inserted through the anchor head and lies in the hole of the screw head after retraction (latero-cranial view; left = proximal).

Fig. 5: The collateral ligament substitute has been knotted. The ligament replacement suture is fixed in the two bone anchor screw heads (lateral view, top = proximal).

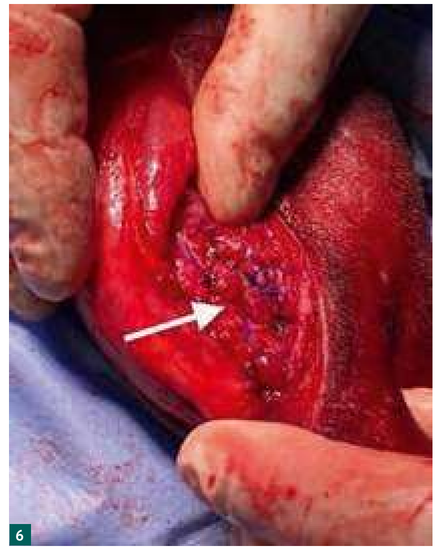

Fig. 6: The cruciate ligament replacement (arrow) was passed through a bone tunnel in the proximal tibia and through the bone anchor on the lateral femoral condyle. The stability of the knee was tested using a drawer test.

Treatment of an elbow dislocation in a cat

A three-year-old domestic cat suffered a dislocation of the left elbow in an encounter with a motorbike. The radius and ulna presented lateral to the humerus, reduction was attempted but despite spica splinting the elbow dislocated again within 24 hours. After medial access to the elbow joint, the radius and ulna could be reduced using Metzenbaum scissors. The medial collateral ligament was pinned to the epicondyle. The medial humeral ligament was sheared off, the ligament remnants only very short. A 2.4 mm bone anchor was screwed into the medial humeral condyle with polyester thread (USP 1) (Fig. 8) already inserted into the anchor head after pre-drilling. The suture was placed in the ligament remnants on the distal side using a locking loop pattern and then knotted.

Fig. 7: Postoperative X-ray images of the first case: the two anchor screws are located on the lateral side of the knee joint. The proximal screw served as an anchor point for the collateral ligament and cruciate ligament replacement.

The medial muscles and fascia were closed with polydioxanone, with the sutures reinforcing the primary fixation with bone anchor and suture. After closure of the wound and X-ray imaging (Fig. 9) of the operated elbow, the cat's front leg was placed in a carpal sling for 3 weeks. The cat also suffered trauma due to soft tissue injury which led to subsequent soft tissue necrosis, as a result of which the front leg had to be amputated 20 days after initial treatment.

Reinforcement of an extracapsular replacement of the cruciate ligament in dogs

A lateral ligament replacement with polyester USP 5 was chosen to treat a cranial cruciate ligament rupture in a 13-year-old miniature poodle. After the first suturing around the lateral Fabella and through 2 bone tunnels in the tibia, a cranial instability of 4 mm was determined. After repeated insertion of the suture and knotting, the instability was still 3 mm. It was decided to supplement the knee with a medial ligament replacement. For this purpose, a 1.6 mm bone anchor was screwed into the medial femoral condyle and into the proximal crista tibiae. A polyester thread (USP 1) was pulled through the holes of the bone anchors using an insertion aid and tied using a sliding knot. Subsequently, no more shear loosening was observed. The miniature poodle was discharged after X-ray with a 6-week rehabilitation plan and was walking lameness-free after 8 weeks.

Discussion

The difficulties in reconstructing a ligament in small animal orthopaedics are essentially:

- Often only short ligament remnants, which cannot be adequately secured with sutures,
- Bone tunnels for anchoring are always only approximations because there is entry and exit from the bone,
- lack of co-operation after the operation.

Bone anchors address these problems in many ways. They can be placed exactly where the sheared ligament originated or inserted or where the surgical team wishes to place it. This is particularly useful in extracapsular ligament replacement for the previous cruciate ligament, which utilises its biomechanical advantages when the anchoring points are as close as possible to the origin and insertion of the original ligament (Hulse et al., 2010). The good post-operative course of the two cases with a torn anterior cruciate ligament confirms the specifications from ex-vivo tests, where the proof of the sufficient tear-out stability of the bone anchors at the knee joint was demonstrated (Roca et al., 2020; Tassani et al., 2024).

The specially designed holes in the bone anchors also cause less friction on the thread than in a bone tunnel, which means that the thread is less likely to break prematurely. Multiple threads can be fixed to individual anchors. This was achieved in the anchors presented here by means of double drilling and was successfully implemented clinically in cats with lateral and cruciate ligament tears. In addition, the screw heads are kept short, which should lead to significantly fewer foreign body reactions than the previously used combinations of conventional screw heads and washers. The surgical team does not have to worry about the thread slipping away. The threading aid proved to be very useful and was particularly effective in guiding the ligament replacement through the eyelet in cases of lateral ligament tears and cruciate replacement of the stifle. The screws were then screwed in a few more turns to their final position.

8

Fig. 8: Thanks to the slits in the screwdriver blade, the anchor screw can be screwed in with the thread inserted.

9

Fig. 9: Postoperative X-rays after reduction of a dislocated elbow and fixation of the medial collateral ligament with bone anchors.

In contrast, this procedure was not possible in the elbow due to the depth of the humerus in the musculature. Instead, the thread that had already been inserted was introduced using a screwdriver with a slot made specifically for this purpose. In all cases, a pilot hole was drilled first with a small Kirschner wire.
The anchors are made of titanium,with the advantage of increased resistance to infection over stainless steel counterparts (Disegi, 2000; Eijer et al., 2001), however the modulus of elasticity is therefore around half as high and as the bending force of a screw also depends on the fourth power of the cross-section, only a residue of approximately 18 % remains in clinical use, which is usually compensated for by a thicker implant (Muir et al.,1995). A consideration when using anchors is that the screw remains in the body and in the event of loosening would need to be removed with another operation.

The three cases presented above are only a small selection of potential applications. In our opinion, bone anchors can be used without any problems as collateral ligament replacements in the carpus, tarsus, elbow and stifle. Their use as medial collateral ligament replacements in the shoulder joint or as anti-rotational threads in hip joint luxation (Slocum technique) requires clinical testing. The screw heads may prove to be too large for the reconstruction of ligaments after toe luxation. Although already used, the question of its indication as a replacement for the cranial cruciate ligament remains unanswered, as there is no long-term clinical experience and the bone anchor system was only used as an additional therapy in one case. We therefore do not recommend it as a primary fixation technique for cranial cruciate ligament tears, but see potential for replacing the caudal cruciate ligament, which rarely tears.

The first applications of the new bone anchor system confirm the experiences of other authors with similar fixation techniques (Robello et al., 1992; Balara et al., 2004; Visscher et al., 2019; Logothetou et al., 2022; Tassani et al., 2024) and expand the areas of application. The advantages are the simple fixation of the anchor deep within the tissue and the possibility of inserting at least two threads through the same anchor head.

Disclosure of conflicts of interest

The authors were provided with the new bone anchor systems at favourable conditions. DK is a regular speaker at Eickemeyer Medizintechnik für Tierärzte KG. The rights to figures 3 to 7 and 9 are held by the authors, those to figures 1, 2 and 8 by Eickemeyer Medizintechnik für Tierärzte KG.

In Memoriam

We dedicate this article to our dear colleague Dr. Michael Koch, who tragically died far too young in a traffic accident.

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Studied in Fribourg and Zurich, graduating in 1990. After an internship in Utrecht, Netherlands, Daniel Koch worked as an assistant and senior assistant at the Small Animal Surgery Clinic at the Vetsuisse Faculty of the University of Zurich, where he became an ECVS Diplomate in 1999. He has been working as a private surgeon since 2004 and has had his own referral practice in Diessenhofen since 2010. His areas of expertise are joint surgery, osteosynthesis, airway obstructions and dental treatment; his research interests include brachycephalic syndrome and the knee joint in dogs. Daniel Koch is married, has three children, three grandchildren and one dog.

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Studied veterinary medicine at LMU Munich, graduating in 1999, doctoral thesis at the University of Zurich, MSRU on bone substitutes in 2001. An AO-ASIF Fellowship at Texas A&M University followed by an internship programme at the University of Glasgow until 2002, followed by a research fellowship at Ohio State University, paved the way for me to enter the residency programme at Tufts University. From 2007 to 2009, I worked at the University of Florida as an assistant physician.
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