TATE™ TOTAL ELBOW REPLACEMENT UPDATE
Loïc M. Déjardin, DVM, MS, DACVS, DECVS
Reunan P. Guillou, Doc. Vét.
College of Veterinary Medicine
Michigan State University, East Lansing – Michigan

Key Points
• Unlike previous elbow prostheses, the TATE is a cementless, resurfacing press-fit design implanted as a single unit using minimally invasive surgical techniques
• Subjective evaluation suggests that long term functional recovery and severe complication rates compare favorably to those of stemmed cemented designs.
• Prospective experimental and clinical evaluations as well as retrieval analysis are ongoing and may provide some needed objective data in the near future.

Thanks to the development and refinement of new prosthetic designs (Conzemius, Acker – Van Der Muellen, Wendelburg – Tepic, Innes), total and hemi elbow replacement (TER) is progressively becoming a realistic option for the treatment of intractable end-stage canine elbow osteoarthritis otherwise non responsive to medication and/or physical therapy. While most systems remain cemented, unlinked, semi-constrained, stemmed designs, a novel TER system (TATE Elbow™) was recently devised by Acker and Van Der Meulen (Fig. 1). This proceeding which focuses on the TATE Elbow™ prosthesis, describes recent modifications in implant design and surgical technique and summarizes clinical results and complications.

TATE design and surgical procedure:
Similar to Conzemius’ prosthesis, the TATE is an unlinked, semi-constrained design. However, several differences exist between these two systems and may explain the improved time-matched results seen with the TATE. Unlike previous conventional stemmed and cemented systems, the cementless TATE implant was designed to use a novel resurfacing concept, as well as minimally invasive surgery (MIS).

In an effort to reduce the incidence of lateral luxation and humeral/ulnar fractures (complications seen with stemmed prostheses) both surgical technique and implant design were drastically modified from those used with previous prostheses. From a surgical standpoint, the
elbow is approached via an osteotomy of the larger medial humeral epicondyle rather than a desmotomy of the lateral collateral ligament. In addition, the articular surfaces of the humerus, radius and ulna are simultaneously removed without luxating the elbow using a precision milling tool (Fig. 2). This less invasive approach preserves both collateral ligaments and the majority of the osseous frame supporting the prosthesis, thus potentially enhancing postoperative stability, reducing morbidity and hastening functional recovery.

Figure 2: Schematics of the surgical procedure critical steps. A) The elbow joint is exposed via a medial epicondyle osteotomy then locked at ~90° of flexion using an alignment plate. B) A milling tool simultaneously removes the articular surfaces of the humerus, radius and ulna, creating a circular groove centered on the humeral trochlear. C) The TATE cartridge is impacted into the articular space left after milling. D) The medial epicondyle is reattached using lag screws.

Accurate milling of the articular surfaces is a challenging yet critical step to achieving the tight implant/bone interfaces required to optimize long-term secondary fixation via bone ingrowth. This step has been greatly facilitated by the use of a redesigned alignment plate that features a humeral arm and fixed-angle locking plate holes (Fig. 3 Left). The TATE prosthesis is a cementless system initially stabilized through a “press-fit” mechanism. Long term stability relies on bone ingrowth into the porous structure of the implants. In an effort to optimize osteointegration, a 2nd generation TATE Elbow was released early 2010 (Fig. 3 – right). Design modifications included hollow (rather than solid) primary fixation posts and hydroxyapatite coating of the original porous prosthetic surfaces. To reduced prosthetic interfacial shear stresses and thus further promote osteointegration, articular congruity was decreased through modification (flattening) of the radioulnar articular profile. This, in turn significantly limited rotational and mediolateral translational constraints. While implant loosening has not yet been reported with either TATE generation, these design iterations, were mainly intended to promote implant osteointegration. The 2nd generation TATE has been used in ~30 clinical and 6 experimental cases worldwide.

A unique characteristic of the TATE system is that both components are impacted simultaneously as a pre-assembled cartridge (Fig. 3). This guarantees accurate alignment and tracking of the prosthetic components throughout range of motion, and likely reduces shear stresses at the bone-implant and articular component interfaces. This in turn may optimize osteointegration of the prosthesis and lessen the risk of aseptic loosening secondary to premature wear. Cementless prostheses have potential advantages over the currently used cemented model, including reduced risk of infection and reduced rate of implant wear, both of which are regarded as leading causes of post-operative morbidity and implant failure.
Clinical outcome:

While clinical and experimental studies are ongoing at Michigan State University, no objective data is available on the clinical outcome of the TATE Elbow system. The following data was compiled from feedback from 6 centers where more than 5 cases were performed (total 75 elbows). We emphasize that this information is subjective in nature and therefore should be assessed cautiously. The TATE prosthesis has been implanted in approximately 160 cases worldwide since July 2007 (~4 years ago).

Subjective clinical evaluation and feedback from dog owners suggest that limb function improves up to 1 year after surgery following a typical aggravation of the lameness between 6 and 12 weeks. Although dogs appear pain free and show improved range of motion, mainly in extension, subtle to mild lameness may persist.

Severe complications (n=4) consisting of two humeral fractures, one ulnar fracture and one implant loosening were recorded, all within 8 weeks post-operatively (rate ~5%). Of these, two cases were associated with secondary infection and one with secondary ulnar fracture. Two cases were euthanized by the rDVM without reevaluation by the primary surgeon and one was amputated due to concomitant deep infection. The primary ulnar fracture was successfully revised using a plate and tension band combination. In addition, excessive periprosthetic osteolysis around the RU component has been documented 6 weeks post-operatively. While the dog lameness has improved 6 months after surgery, the risk of aseptic loosening remains a real concern. Elbow luxation and primary ulnar fracture, complications seen with the Iowa State system, have not been reported in any but one (ulnar fracture) cases.

Minor complications including pin migration, screw loosening, fracture of the medial epicondylar fragment, occurred in early cases and were all successfully revised. Other, clinically inconsequential, minor complications such as skin dehiscence and neuropraxia have been reported.

Iatrogenic intra-operative complications due to surgical errors (transection of the ulnar nerve and trochlear fracture) were described by Acker in one dog who remains ambulatory three years post-operatively.

We have limited knowledge of twenty more cases treated with the assistance of a trained surgeon. Severe complications occurred in 20% of the cases (humeral fractures [n=2] and infections [n=2]). Revision consisted of successful primary fracture repair, amputation or arthrodesis. One dog was lost to follow-up.
**Objective force plate analysis** was conducted on 6 patients at Michigan State University up to 30 months after implantation of a TATE elbow system (ongoing prospective clinical study). In all cases, pre-operative peak vertical force of the affected limb was significantly lower than normal reported range of 105% to 125% BW at the trot. By 6 to 12 months after surgery, the peak vertical force of the operated limb was greater than that of the contralateral side. Continued improvement was seen at 2 years, as the peak vertical force of the operated limbs had returned to a normal reported value of ~115% BW. One dog underwent bilateral elbow replacement. That dog received a 2nd generation TATE prosthesis 2 years after successful implantation of a 1st generation implant (Figure 4).

Prospective experimental and clinical evaluations of the TATE Elbow system as well as retrieval analysis are ongoing and may provide some needed objective data in the near future.

![Figure 4: Force plate analysis of a dog that underwent bilateral TATE elbow replacement. Peak vertical force as a percentage of body weight is on the y-axis; time in month is on the x-axis. Please see text for details.](image)

Regardless of design, a major limitation of TER is the absence of effective revision options in case of failure. Unfortunately, because end-stage elbow OA is often a bilateral condition, amputation is not a valid option in most cases and arthrodesis remains the main alternative. Although some fractures or luxations may successfully be revised, others may require explantation and arthrodesis because of the limited bone stock available for implant fixation. Infection is and will likely continue to be the most challenging complication as antibiotic therapy alone is unlikely to be effective as long as the prosthesis is implanted. Because of these limitations, owner education is critical and must be thorough and objective. A fair disclosure of alternative treatments and realistic expectations particularly with regards to complications and revisions should be presented to anyone contemplating TER.