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Summary
A six-year-old, female, spayed Labrador Retriever was evaluated for progressive lameness of one year duration, ending in non-weight-bearing of the right hindlimb. The dog had a history of severe coxarthrosis of both hip joints, and had a HELICA hip prosthesis implanted in the right hip 18 months before. On survey radiographs, the acetabular and femoral components appeared unstable, with a large void in the proximal femur and a lacy periosteal reaction on the trochanter. Arthrocentesis was performed to rule out septic loosening. As culture samples were negative, the dog underwent surgery. We report the successful revision of an unstable HELICA screw hip prosthesis with a Zurich cementless total hip replacement. The patient had a good clinical and radiological outcome seven months postoperatively.

Introduction
Cemented and cementless total hip replacements (THR) are treatments which are indicated for dogs with pain secondary to dysplasia, coxarthrosis, coxofemoral luxation, and irreparable fractures of this joint (1). Clinical success following these procedures is good, with complications reported between seven to 22% (2–6). Failure of the implants may be due to septic or aseptic loosening (2–5, 7, 8) which then leads to revision surgery. Resorption, subsidence and cortical thinning are recognised events in stable and unstable THR (9–12). Differentiation between septic and aseptic loosening however can be very challenging in some patients. Diagnostic imaging and arthrocentesis are common tools used to identify the cause of loosening in human medicine (13, 14).

A new femoral cervical implant has been developed and designed for dogs based on a screw-shaped prosthesis (15). Unstable femoral cervical components and femoral fracture were present in three out of 40 patients in a time frame of one year, and only one could be successfully revised on initial report, whereas cup revision had a higher success rate (15).

This case report describes the revision of an unstable HELICA prosthesis with a Zurich cementless THR.

Case study
A 28.4 kg, six-year-old female spayed Labrador Retriever was evaluated for progressive lameness of one year duration which ended in non-weight-bearing of the right hindlimb. The dog had a history of severe coxarthrosis of both hip joints which had been treated at an earlier time point with gold beads (16). The patient was implanted with a cementless cervical screw hip endoprosthesis on the right hip 18 months before. On physical examination, the right hindlimb could not be fully extended and atrophy of the right pelvic musculature was evident. Haematology and serum biochemical analyses were within reference limits. Survey radiographs (▶Fig. 1A, B, and C) of the pelvis revealed a wide area of bone resorption surrounding the neck of the prosthesis, which appeared loose. It was demarcated with a sharp sclerotic margination of bone tissue. Periosteal new bone formation adjacent to the greater trochanter was present and was characterised by a relatively aggressive pattern. Pitting of the femoral component was evident when compared between extended and flexed radiographic views of the femur (▶Fig. 1A and B). The femoral implant appeared to move several millimetres depending on the position and view taken. The acetabular cup had a complete radiolucent line around it, surrounded by a sclerotic line in its cranial area suggesting loosening with micro-motion. Atrophy of the right gluteal musculature supported the clinical history of disuse of the limb. The radiographic diagnosis was loosening of the right total hip prosthesis requiring further investigations to rule out the presence of bacterial infection.

The patient was placed in lateral recumbency under general anaesthesia; the right hip region was aseptically prepared, and a 1 cm skin incision was performed craniodorsal to the greater trochanter to decrease the risk of iatrogenic contamination of the sample. A 22-gauge, 7.62 cm spinal needle...
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fluorane in oxygen, and fentanyl at a constant rate of infusion (10 μg/kg/h) was administered during the surgical period. The right hip was approached through a standard cranialateral approach. The joint capsule was thickened and the implants were found to be loose. The unstable implants were easily removed. The acetabulum and proximal femur were surgically debrided of necrotic material. The proximal endosteal aspect of the femur was prepared for the insertion of the femoral component using a standard surgical technique (17). The debrided material was submitted for histological and bacteriological examination. A 32.5 mm cup, a 19 mm medium head-neck, and the small stem of a cementless hip prosthesis were positioned. Because of the thin sclerotic medial cortex, the fixation of the new prosthetic stem was enhanced by placing two bicortical screws (3, 17). The stability of the weakened trochanter was buttressed with a 2.4 locking internal fixator using five 3.0 mm monocortical screws in the greater trochanter and in the lateral cortex of the femur. A gentamycin sulfate impregnated sponge was placed in the joint before closing the surgical wound. Postoperative radiographs revealed good implant positioning (Fig. 3A and B). The angle of lateral opening was 50º and the angle of inclination was 30º (3).

Histology revealed a chronic, proliferative arthritis with necrotic centres and granulomatous inflammation with no neoplastic cells identified. Intraoperative culture from debrided material reported no growth of bacteria.

The patient was discharged from the hospital with oral analgesics (3 mg/kg tramadol three times daily; 4 mg/kg carprofen once daily) and antibiotics (22 mg/kg cefazolin twice a day) prescribed for ten days. The patient was weight-bearing one week later. The patient was premedicated with 0.003 mg/kg acepromazine and 0.007 mg/kg buprenorphine (IM) and induced with propofol 4 mg/kg (IV). Epidural anaesthesia was performed with 0.1 mg/kg morphine and 0.5 mg/kg bupivacaine, and narcosis was maintained with iso-

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**Fig. 1** Radiographic images of the pelvis of a six-year-old Labrador Retriever with a 12-month-history of progressive lameness. The presence of periarticular gold beads belongs to a previous treatment. A) Ventrodorsal view with legs extended, B) flexed ‘frog leg’, and C) latero-lateral position. Note the contact between the femoral neck and the stop of the right femoral component when compared to the ventrodorsal projection (black arrow). The femur has a range-of-motion of 4 mm with the femoral head and neck when comparing extended and flexed views of the femur.

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b Prequilan: FATRO S.p.a., Ozzano Emilia, Italy
c Temgesic®: Essex Chemie AG, Luzern, Switzerland
d Propofol 1%: Fresenius Kabi AG, Stans, Switzerland
e Morphine HCl: Sintetica S.A., Mendrisio, Switzerland
f Carbosetin®: AstraZeneca AG, Zug, Switzerland

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7 Isoflo®: Abbott AG, Baar, Switzerland
8 Sintenyl®: Sintetica S.A., Mendrisio, Switzerland
9 Zurich Cementless Prosthesis: Kyon AG, Zurich, Switzerland
10 Unilock 2.4 plate: Synthes Gmbh, Switzerland
11 Garamycin Espponge: Merlonipharma, Chiasso, Italy
12 Tramadol: Helvepharm AG/SA, Frauenfeld, Switzerland
13 Rimadyl: Pfizer AG, Zurich, Switzerland
14 Kefol®: Teva Pharma AG, Aesch, Switzerland
week after surgery and improved during the following weeks, gaining muscle mass. There was no lameness present, the muscle mass was improving, and the range-of-motion of the operated limb was reduced in extension by approximately 10° to 20°, and there were no signs of pain. A direct comparison with the opposite side was difficult due to the extensive arthritic changes present.

Follow-up radiographs of the prosthesis at seven months postoperatively did not show any signs of instability or other complications (Fig. 4 A and B). Complete integration of the hip components was present and the trochanteric defect was filled with new bone.

Discussion

We report the successful revision surgery of an unstable screw-hip prosthesis with a cementless THR. Aseptic loosening is a common complication of cemented total hip prosthesis, and was the second most common short-term complication observed after cemented THR in dogs with an incidence rate of 2.1%, however its prevalence is difficult to ascertain because it is often not clinically apparent, and does not always necessitate revision surgery (9, 19–21).

In a review of retrospective studies of canine THR, aseptic loosening of the femoral component requiring revision was reported in three percent of cases with long-term follow-up (2, 22, 23). However, no objective engineering analysis was performed to verify the clinical performance of THR in dogs. Two ex vivo studies showed that the incidence of aseptic loosening of canine cemented acetabular and femoral components was high, with a rate of 52.6% and 63.2% respectively that tested loose in these series.

In the latest study on Zurich cementless THR, aseptic loosening of the cup was reported in three percent of the cases, and there was also one femoral fracture due to thin sclerotic cortices reported. However, all were surgically repairable (3).

The radiographic signs secondary to femoral implant loosening may include cortical thickening, progressive radiolucent lines at implant interfaces, evidence of implant pistoning, and for cemented THR, fracture lines within the cement mantle (7). The lacy periosteal new-bone formation about the femoral cortex on plain radiographs is a pathognomonic sign for deep infection in human medicine (13, 14).

The radiological appearance of the greater trochanter and the radiolucent region around the acetabular component rendered a clear distinction between osteomyelitis and reactive proliferations due to instability, which can be difficult to diagnose solely on radiographic examination.

Diagnosis of infection in a total hip arthroplasty in humans may require the use of extensive laboratory investigations, including radiography, nuclear imaging, examination of peripheral blood for determination of the erythrocyte sedimentation rate and C-reactive protein level, and aerobic and anaerobic incubation of clinical material obtained by aspiration of the joint (13, 14). Percutaneous needle aspiration has been reported to be an accurate means of identifying bacterial contamination, however this procedure may be associated with the risk of introducing bacteria into a sterile joint, and is reliable in only 50% of cases (24–26). In our patient, the preoperative cultured samples were negative, which was further confirmed by intraoperative bacteriological and histological analysis of the debrided material.

Based on our experience, placing pressure on the pectineus muscle at its insertion point on the pubis, and on the ventral region of the joint capsule, will distend the dorsal aspect of the joint.
The trochanteric defect is filled in with new bone. Complete integration of the acetabular and femoral component is achieved.

Different techniques are reported to replace loose septic or aseptic implants. Revisions are done by cemented or cementless implants, but cemented revisions for loose cups have shown to have a high failure rate in human medicine (27, 28). Consequently, cementless cup implantation with or without use of allograft has become more popular, in particular where peripheral press-fit fixation can still be achieved (29). As stated within other studies, the removal of the implants was easily performed and required a short operating time (3, 15).

In one study regarding HELICA endoprosthesis usage, the authors reported signs of resorption or instability at the implant-bone interface one year postoperatively in 17.5% of the 40 THR surgeries performed (cup loosening [n = 3], cup and stem loosening [n = 1], resorption under the collar of femoral prosthesis [n = 2]; [15]). One possible explanation for the two cases that experienced stem loosening may be that the distribution of loading on the femoral neck and the femoral head was offset. Indeed, the physiological load is on the medial cortex; a greater distance between the centre of the head and femoral axis would increase stress and bending moments on the femoral implant (30). The varus-valgus positioning of the femoral component could have played an important role as well, even if the correct angle of the femoral neck prosthesis was automatically achieved during insertion (15). The two patients with resorption under the collar were not revised because no signs of severe lameness were displayed. Resorption, also known as stress shielding, is a normal phenomenon which occurs between bone and stiffer material (30). However, these patients were not followed further and it was not possible to know if loosening or subsidence of the stem happened at a later time point. Stem subsidence is a well recognised complication of un-cemented total hip arthroplasty prostheses when the implant size is incorrectly chosen or malpositioned (11, 12). Our dog was presented with a mediolateral piston effect which was noted when comparing the extended and flexed ventrodorsal radiographic views of the pelvis. Identical problems were encountered for the femoral component in a similar human prosthesis where aseptic loosening ranged from six to 21 % (31, 32).

Femoral cortical bone loss is a reported complication of stable and unstable cemented THR (9, 10). For our patient, the trochanter had a large void which was caused by osteolysis due to the persistent movement of the loose femoral neck component.

However, the ultra-high molecular-weight polyethylene particles resulting from polyethylene wear has been accepted as causing late osteolysis in total hip arthroplasties (33). This foreign-body response is unlikely to have contributed to bone loss and resorption at the implant-bone interface in our patient as polyethylene particles were not identified histologically, and the patient never used the limb. In a study by Hach et al., the revision of the screw-shaped femoral implant seemed more difficult because the centering achieved by drilling a larger hole was not easy to obtain (15). The end result for one patient with stem loosening, and one with femoral fracture, was excision arthroplasty because stability could not be obtained during revision surgery (15). The increase of cortical thickening elicited by Zurich implants anchorage to the medial cortex, where most of the physiological load is distributed, would have overcome this problem (3).

A medium-sized stem would have been more appropriate based on the size of our patient. However, a more extended reaming would have been required to achieve the correct anteverision of a larger stem, which may have injured or broken the already weakened trochanter. A locking plate was used to bridge this region to prevent a possible fracture of the proximal femoral metaphysis and trochanter. This method was previously adopted only to relieve stress on thin cortices with disuse atrophy, after osteotomies, femoral shaft fractures or after implant removals (3, 34). The decision to buttress the lateral proximal femoral region depends on the extension of the bone lysis and possible reaction. The risk of a trochanteric fracture due to the large proximal femoral defect had to be considered in our patient.

It may be concluded that revision with a Zurich cementless THR could be a good and effective replacement procedure in non-infected, highly unstable screw endoprosthesis. The fixation of the stem with locked screws to the intact medial cortex is an effective technique, even when marked osteolysis of the proximal femoral metaphysis and greater trochanter are present. This situation would have otherwise led to femoral head and neck excision (15).

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