Permanent Iatrogenic Fibular Nerve Injury following Tibial Plateau Levelling Osteotomy

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Abstract

The aim of this study was to describe three dogs with permanent fibular nerve injury following tibial plateau levelling osteotomy (TPLO). Fibular nerve injury following TPLO led to atrophy of the cranial tibial muscle, absent hock flexion and a mild lameness. Fibular nerve injury was confirmed in one case with electrodiagnostics. All three cases had a drill tract in the same location, on the caudal aspect of the tibia, immediately distal to the tibial osteotomy. Permanent fibular nerve injury following TPLO occurred with a more caudally positioned plate and care should be taken when drilling the tibia from medial to lateral in the region described. Careful gait assessment at routine follow-up was required to identify this complication.

Keywords
- fibular nerve injury
- peroneal nerve
- TPLO

Introduction

Numerous surgical techniques have been described for the management of cranial cruciate ligament disease, with tibial plateau levelling osteotomy (TPLO) being commonly reported.[1] Reported complication rates following TPLO range from 9.7 to 28%.[2–6] The most common complications reported include infection,[6] incisional oedema, haematoma or bruising,[2] pivot shift,[5] osteomyelitis,[4] tibial tuberosity fracture, delayed union, patellar desmitis[7] and seroma.

Injury to the common fibular nerve (also known as the common peroneal nerve) is a rarely reported complication following TPLO. To the author's knowledge, this complication has been reported once following TPLO, a Labrador with perineural fibrosis due to entrapment of the fibular nerve caudal to the fibular head.[8] This case had a good outcome with resolution of the fibular nerve deficit by 3 months following external fibular neurolysis.

The common fibular nerve is one of two terminal branches of the sciatic nerve and courses down the lateral aspect of the stifle joint and crus. The nerve innervates the cranial tibial muscle and digital extensors, allowing hock flexion and digit extension. Just distal to the stifle it divides into the superficial and deep fibular nerves.[9] The superficial fibular nerve innervates the fibularis brevis, lateral digital extensor, fibularis longus and provides cutaneous sensation to the craniolateral aspect of the crus. The deep fibular nerve innervates the proximal end of the fibularis longus, cranial tibial muscle, extensor digiti I longus and the three heads of the extensor digitorum brevis.[9]

Damage to the common fibular nerve, or to both the superficial and deep branch, results in extension of the hock and knuckling of the paw. The dog adapts with greater flexion of the hip and extension of the stifle joint to place the foot properly. The dorsal aspect of the paw loses sensation.[10]

This case series reports three cases of suspected permanent iatrogenic fibular nerve injury following TPLO with similar post operative radiographic findings suggesting a possible risk factor for this complication.

Materials and Methods

Given the rarity of the diagnosis, cases were identified by asking attending surgeons for any cases they have seen with

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suspected fibular nerve injury over a 10-year period (2012–2022) from Langford Vets, University of Bristol in the United Kingdom. Clinical records, including any associated radiographs and electrophysiological testing results were reviewed for each case. Follow-up data were available from clinical records and were based on re-examination at the operating centre, routinely performed 8 weeks following surgery.

Each case was diagnosed with cranial cruciate ligament rupture via arthrotomy. Surgeries were performed by an European College of Veterinary Surgeons (ECVS) resident in small animal surgery under direct supervision by an ECVS diplomate in small animal surgery. Neurological examination findings were provided by an European College of Veterinary Neurology (ECVN) diplomate. A mini medial arthrotomy was performed to check meniscal status and partial meniscectomy was performed if indicated. No meniscal release was performed. A TPLO was performed as described by Slocum and Slocum but without the use of a jig.[1]

No bandages were applied following surgery and each case had a femoral and sciatic nerve block performed prior to surgery. All pre- and postoperative radiographs included orthogonal views of the tibia. Cases were discharged 24 to 48 hours following surgery, often with poor limb use at this early stage.

For anatomical representation of the path of the common fibular nerve three-dimensional (3D) model renders were developed using computed tomography reconstruction together with hand sculpting processes. This primarily occurred in Zbrush sculpting software (Pixologic, Maxon Computer GmbH, Basler Str. 5, 61352 Bad Homburg vor der Höhe, Germany), together with Substance Painter (Adobe, California, USA) for texturing and Adobe Stager (Adobe, California, USA) and Blender (Blender version 2.82, blender.org, Blender Foundation, Amsterdam, Netherlands) for rendering. Computed tomography data were acquired from a previous database of a dog not included in this study.

Results

Three cases were identified with suspected fibular nerve injury: A 9-year-old female-neutered English Springer Spaniel (case 1), a 7-year-old male-neutered Staffordshire Bull Terrier (case 2) and a 3-year-old female-neutered American Bulldog cross breed (case 3). Cases 1 and 2 had a unilateral TPLO secured with a 2.7 and 3.5mm locking TPLO plate respectively (Synthes) and case 3 had a bilateral TPLO secured with a 3.5 mm small locking TPLO plate (left, Synthes) and a 3.5mm locking TPLO plate (right, Synthes). On the immediate postoperative radiographs, cases 1 and 2 were found to have a discrete radiolucent circular cortical defect on the caudal aspect of the tibia. This is consistent with a drill tract just caudal to the TPLO plate immediately distal to the osteotomy. Case 3 had a caudally positioned TPLO plate on the right tibia without a visible cortical defect but with the first screw of the distal section in the same location as the previously described cortical defects (►**Fig. 1**). Each case had a single set of follow-up radiographs at the time of the first re-examination. For each case, radiographs demonstrated good progression of bone healing and no implant-related abnormalities.

Case 1

This case was seen for its first re-examination 6 weeks following surgery. There was a mild right hindlimb lameness, knuckling of the right paw and muscle atrophy of the right hind limb. The specific location of muscle atrophy was not recorded. There was no hock flexion evident at walk. At 10 weeks following surgery, there was increased flexion of the hip at walk, with no evidence of hock flexion. The withdrawal reflex was abnormal, there was no flexion of the hock, but stifle and hip flexion was elicited. The patellar reflex was normal and there was atrophy of the cranial tibial muscle. These clinical findings were consistent with absent common fibular nerve function. This case underwent 6 weeks of neuromuscular electrical stimulation with a progressive return to exercise alongside daily non-steroidal anti-inflammatory medication. There was no improvement with this treatment and the dog continued to have progressive muscle atrophy of the right cranial tibial muscle and a high stepping gait with occasional knuckling of the right hind limb. The neurological examination findings remained static. Further investigations into the cause of the neurological deficits were declined. The dog was last seen for a re-examination 5 months following surgery, with a persistent mild lameness and the clinical signs as described above.

Case 2

This case was seen for its first re-examination 7 weeks following surgery. There was a mild right hindlimb lameness with what was described as an 'exaggerated' gait, flicking the limb forward when compared with the left side. No specific treatment was recommended at this stage. At the final re-examination 6 months following surgery, the gait was the same as described 7 weeks following surgery with a persistent mild lameness. Neurological examination at 6 months identified muscle atrophy of only the right cranial tibial muscle. Cutaneous sensation to the limb was normal. Arthrocentesis of the right stifle joint was cytologically consistent with osteoarthritis. Consultation with a veterinary physiotherapist was recommended and no further follow-up was available.

Case 3

This case was seen for its first re-examination 6 weeks following surgery. There was increased flexion hip at walk, with no evidence of hock flexion. No further neurological deficits were identified on examination. No specific treatment was recommended at this stage. At the final re-examination 5 months following surgery, there was reduced flexion of the right hock at walk and a mild right hindlimb lameness. A full neurological examination was limited due to the dog's behaviour. Arthrocentesis of the right stifle joint was cytologically consistent with osteoarthritis. An electrodiagnostic study was performed of the right pelvic limb under general anaesthesia. This identified changes compatible with a right deep and superficial fibular neuropathy. Electromyography of the affected right limb showed abnormal spontaneous activity (fibrillation potentials) in the

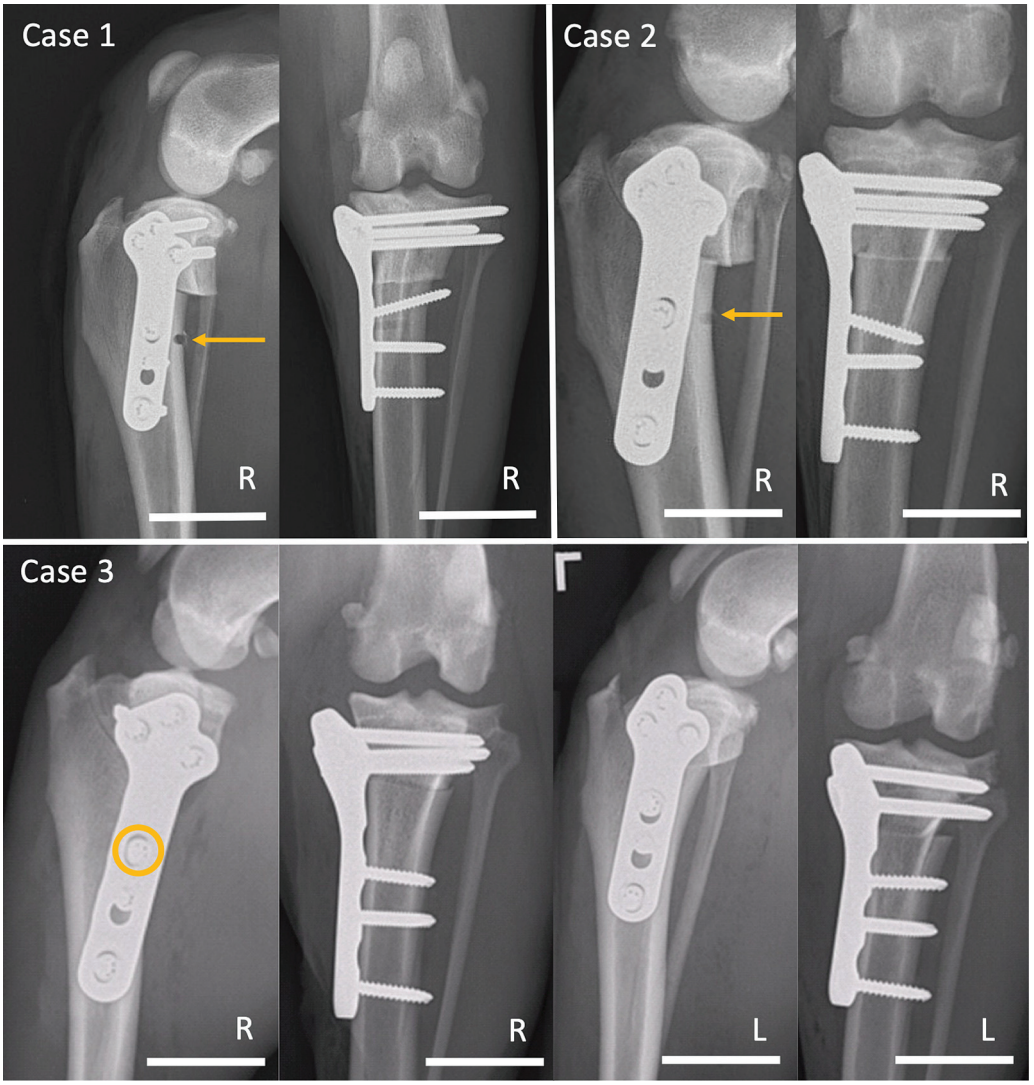

Fig. 1 Mediolateral and caudocranial postoperative radiographs of all three cases taken immediately following surgery. The orange arrows indicate the radiolucent drill hole on the caudal aspect of the tibia. The orange circle indicates the similarly positioned screw in the caudally positioned tibial plateau levelling osteotomy (TPLO) plate in case 3. The left limb of case 3 shows a more traditionally positioned TPLO plate. This left limb did not develop any neurological deficits. The white line size marker is 25 mm.

cranial tibial muscle. The contralateral cranial tibial and the ipsilateral semitendinosus, biceps femoris, gastrocnemius and plantar interossei muscles were normal. Motor electroneurography of the right sciatic nerve showed a normal nerve conduction velocity (81m/s, reference >53m/s) above the stifle (stimulation points between sciatic notch and caudal lateral femoral condyle). Study of the right fibular nerve (recording the extensor digitorum brevis muscle) identified a reduced compound muscle action potential when stimulating distally at the caudal lateral femoral condyle (1.5mV, reference >15mV).

Six weeks of cephalexin was administered by the case clinician in case of implant associated infection and no further follow-up was available for this case.

Discussion

Based on the above clinical findings and electrodiagnostic findings for one case, we believe we have identified three cases with fibular nerve injury following TPLO. The injuries seen were most consistent with either an axonotmesis or neurotmesis of the deep and superficial fibular nerve with no clinical recovery seen over the course of up to 6 months. The most interesting and consistent finding identified between all cases presenting with this complication was the location of the drill hole for the proximal screw of the TPLO plate in the distal segment of the tibia. In case 1 and 2, this can be seen as a drill hole on the immediate postoperative radiographs, positioned at the caudal cortex of the tibia. We assume that the surgeon initially drilled this hole with a more caudal plate position and then changed the plate position intra-operatively. For case 3, this was associated with a more caudal than planned plate position and therefore a drill and screw placed in an identical position on the caudal aspect of the tibia. In this location, a drill bit passing through both cortices of the tibia would be at high risk of striking the deep and/or superficial fibular nerve (►**Fig. 2**) and could explain the clinical signs experienced in the postoperative

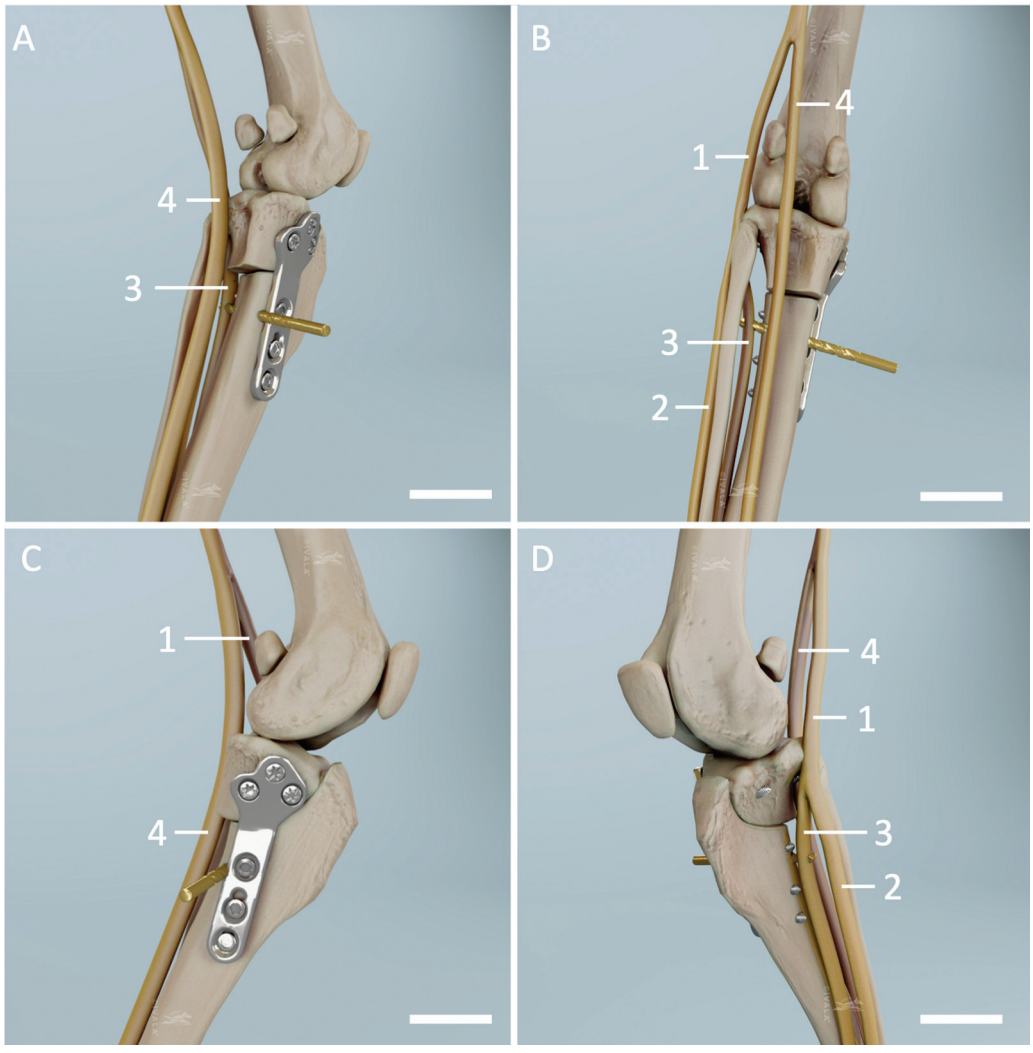

Fig. 2 Three-dimensional model render of a left stifle simulating the proposed mechanism of injury to the deep fibular nerve during tibial plateau levelling osteotomy (TPLO). Four views are provided: A = caudomedial-craniolateral oblique, B = caudocranial, C = mediolateral and D = craniolateral to caudomedial oblique. The TPLO plate is shown in a normal position with the path of the original drill position prior to plate repositioning. 1 = Common fibular nerve, 2 = superficial fibular nerve, 3 = deep fibular nerve, 4 = tibial nerve. The white line size marker is 25 mm.

period following surgery. It is of course possible that nerve injury could occur while performing the radial osteotomy or during administration of a peripheral nerve block. Permanent fibular nerve injury following a sciatic nerve block has not yet been reported.[11] Histopathology or postoperative advanced imaging would be necessary to provide further evidence to support our hypothesis.

Conclusion

Fibular nerve injury is a rarely described postoperative complication that can occur following TPLO. Each of these cases were identified by in-person gait assessment during routine TPLO follow-up consultations. We feel it is important to note that the gait changes were not recognized by the owners and could easily be missed without this assessment. In addition, care should be taken during drilling of the described plate hole and this should not be placed too far caudally on the tibia to prevent possible iatrogenic damage of the deep and superficial fibular nerve.

Authors' Contribution

O.A. contributed to the study design, acquisition and interpretation of data, drafting and revising the manuscript and approval of the submitted version. S.M. helped in the acquisition and interpretation of data, drafting and revising the manuscript and approval of the submitted version. D.C. was involved in the study conception, study design, acquisition and interpretation of data, drafting and revising the manuscript and approval of the submitted version. K.P. contributed to the study conception, study design, acquisition and interpretation of data, drafting and revising the manuscript and approval of the submitted version.

Conflict of Interest

None declared.

Acknowledgment

3D images were developed with IVALA, which creates interactive 3D models for veterinary learning. All learning

content is free to all veterinary students and academics, via membership at VIN.com.

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