Radial Head and Neck Ostectomy Maintained Elbow Joint Function in a Labrador Retriever with Type 1 Congenital Elbow Luxation

Anne Pankowski[1] Jessica McCarthy[2]

[1] Cummings School of Veterinary Medicine at Tufts University, North Grafton, Massachusetts, United States
[2] Department of Clinical Sciences, Madison School of Veterinary Medicine, University of Wisconsin, Madison, Wisconsin, United States

Address for correspondence Anne Pankowski, DVM, Cummings School of Veterinary Medicine at Tufts University, North Grafton, MA, United States (e-mail: Anne.Pankowski@tufts.edu).

VCOT Open 2024;7:e69–e74.

Abstract

A 6-month-old Labrador Retriever was diagnosed with a Type 1 caudolateral congenital right elbow luxation. A radial head and neck ostectomy was performed with no surgical attempt to further stabilize the elbow joint. One year after surgery, objective gait analysis showed only a mild asymmetry in peak vertical forces. Pre- and postoperative Liverpool Osteoarthritis in Dogs scores showed a decrease in perceived pain and a reduction in signs of osteoarthritis. In dogs with congenital radial head luxation, a radial head and neck ostectomy without surgical joint stabilization may be a viable, simple option for a one-time intervention that can reduce pain and signs of secondary osteoarthritis and improve limb function.

Keywords
- radial head and neck ostectomy
- canine elbow luxation
- radial luxation
- radial ostectomy

Introduction

Congenital luxation or subluxation of the radial head is an uncommon canine orthopaedic condition that creates abnormal thoracic limb biomechanics. Elbow luxation can be further specified into three types. When the radial head is luxated from the humerus without humeroulnar luxation, it is classified as Type 1 elbow luxation. A humeroulnar luxation alone is classified as a Type 2 luxation and when both humeroradial and humeroulnar luxation exist in the same elbow it is classified as a Type 3 elbow luxation.[1]

The pathogenesis of congenital elbow luxation is generally attributed to genetics; however, the mode of inheritance for this condition has not been formally identified.[1–6] Most cases of Type 1 elbow luxation, first present between 2 and 5 months of age with a caudolateral luxation of the radial head that is palpable on physical exam. Other physical examination findings include mild lameness, pain on elbow palpation, and a reduced elbow range of motion, particularly in extension.

In Type 1 congenital elbow luxation, the proximal radius typically has a convex epiphysis, as it has never articulated with the humerus. This contrasts with a traumatic or developmental luxation, where the radial epiphysis will be flattened due to the previous articulation with the humerus. The deformity of the articular surface may affect the outcome of radial reduction and it is therefore recommended to try to reduce the radius as early as possible.[7] Early radial reduction will usually require radial ostectomy and further surgery may be required as the patient grows to address asynchronous growth between the radius and ulna.[7]

There have been various proposed surgical procedures to manage Type 1 elbow luxation and the most common from the last 20 years are compiled in ►**Table 1** below, adapted and expanded by Clark and colleagues (2010).[4] Interventions include ostectomy of the radial head, closing wedge radial ostectomy with internal plate fixation, oblique proximal radial osteotomy, ulnar osteotomies, and transarticular pinning.[6,8–12] Techniques to further stabilize the elbow joint after radial or ulna osteotomy include the use of toggles,

received
September 6, 2023
accepted after revision
May 5, 2024

DOI https://doi.org/10.1055/s-0044-1787716.
ISSN 2625-2325.

Georg Thieme Verlag KG, Rüdigerstraße 14, 70469 Stuttgart, Germany

VCOT Open Vol. 7 No. 1/2024 © 2024. The Author(s).

Table 1 Published case reports since 2000

Author	Signalment	Type of luxation	Surgical procedure	Short-term outcome	Long-term outcome	Notes
Spadari and colleagues (2001)[10]	4-mo male Dalmatian	Type 1	Modified Bell–Tawse procedure (wedge ostectomy of proximal radius, plate, and screws, reconstruction of annular ligament, humeroradial transarticular pin)	6 mo: no lameness, normal range of motion	12 mo: no lameness, normal ROM	–
Fafard (2006)[13]	3-mo male Dachshund	Type 1	Closed reduction of the radial head, ostectomy of proximal ulna, stabilization with ESF	4 weeks: using limb 50% of time	None	–
Harasen (2012)[12]	4-mo female Bulldog	Type 1	Ulnar osteotomy, K wire-driven lateral–distal of radial head to medial epicondyle of humerus	Subjectively improved elbow congruity	30% of radial head articulates with lateral humeral condyle	K wire fell out before removal scheduled
Clark and colleagues (2012)[4]	5-mo-old male JRT	Type 1	Modified Bell–Tawse procedure (wedge ostectomy of proximal radius, plate, and screws, reconstruction of annular ligament, humeroradial transarticular pin)	3 mo: mild to moderate weight-bearing lameness, pain on palpation, and reduced ROM	10 mo follow-up; excellent progress and only mild forelimb lameness. At 30 mo, some decreased flexion of elbow, no evidence of elbow pain, only mild intermittent lameness	Radius curvus secondary surgery: osteotomy of ulna, replaced Steinmann IM pin ++ 2 years postop removed plate and screws
Heidenreich and colleagues (2015)[8]	7-mo MN Shih Tzu	Type 1	Radial head ostectomy, fixing radius to proximal ulna with cortical screw, cerclage wire in figure 8 between two screws in lateral humeral condyle and lateral remaining radius	4-6 weeks: gradual reduction in lameness and increase in ROM, no pain or effusion on palpation	11 mo: no lameness or pain, full ROM	–
Kim and colleagues (2020)[6]	5-mo Shih Tzu	Type 1	Single radial oblique and dynamic ulnar osteotomies were performed, 3D osteotomy guide, plate + ESF	3 wk of ESF	3-mo improvement of symmetry index and weight distribution, good elbow congruity, no lameness, and pain	–
Garcia and colleagues (2021)[17]	6-mo male English Bulldog	Type 1	Radial head ostectomy	Weight-bearing, normally 15 days postop	3.5-year follow-up: no lameness or pain and bearing weight, no valgus	–
Chong and colleagues (2022)[5]	16-wk female Border Collie	Type 1	Ultrahigh molecular weight polyethylene suture toggle	6 weeks > good return to function	15 weeks, symmetrical shoulder musculature, decrease in LOAD score	–
Verdese and colleagues (2022)[9]	7-mo FS DSH		Radial head ostectomy	4 weeks: 3/5 lameness, pain on palpation and ROM, ROM symmetrical	2 mo: improved, 2/5 lameness, no pain on palpation or ROM	4 mo: complete resolution of clinical lameness

Abbreviations: ESF, external skeletal fixator; FSDSH, female spayed domestic short hair; JRT, Jack Russel Terrier; MN, male neutered; mo, month; wk, week.
Adapted from Clark and colleagues (2012).[4]

external skeletal fixators, and cerclage wire.[5,8,13,14] Ostectomy of the radial head and neck has been proposed as a simpler, less costly procedure, however to the authors' knowledge there are no case reports detailing the outcome of this and there is concern that elbow stability may be compromised.[7]

This case report describes a radial head and neck ostectomy for the management of Type 1 congenital elbow luxation without concurrent elbow joint stabilization techniques and uses the validated Liverpool Osteoarthritis in Dogs (LOAD) questionnaire and a 1-year postoperation force plate gait analysis to objectively present the outcome.[15,16]

History and Clinical Findings

A 6-month-old intact male 21.2-kg Labrador Retriever presented to XXXX Orthopaedic Surgery Service for evaluation of a radial head luxation of the right thoracic limb. A mild, weight-bearing lameness of the right thoracic limb had been observed since adoption at approximately 6 weeks of age. Following exercise, the lameness was temporarily exacerbated such that it was barely toe touching the limb and this was also seen after a prolonged period of rest. It was examined by its referring veterinarian where an abnormality of the right elbow was detected on palpation. Radiographs of the right elbow revealed lateral luxation of the radial head and a mild radial procurvatum. The intermittent toe-touching episodes had increased in frequency over the 1 month prior to the examination at our institution.

On examination, there was a mild (grade I/V) weight-bearing right thoracic limb lameness at a walk and trot. On initial presentation, the owners were asked to fill out a LOAD questionnaire, where the patient scored 21. According to the LOAD scoring system, the patient had severe osteoarthritis. The luxated right radial head was palpable on the lateral aspect of the elbow. There was normal flexion and reduced extension of the right elbow, with a pain response elicited at the end range of extension. A mild right carpal valgus was observed. The remainder of the orthopaedic examination was unremarkable.

A computed tomography (CT) scan of both elbows was performed (General Electric Lightspeed 8 slice scanner). The CT scan confirmed a right caudolateral radial head luxation (Type 1 congenital elbow luxation) with sclerosis and osteophytosis of the caudal aspect of the humeral condyle and ulna consistent with secondary osteoarthritis (see ►**Fig. 1**). A small subchondral bone cyst of the right caudolateral humeral condyle was present.

Due to the age of the patient, worsening lameness after exercise, and the owner's desire for a low-risk, single-stage surgical procedure with minimal postoperative care requirements, a radial head and neck ostectomy was elected.

Surgical Report

The patient was placed in left lateral recumbency and the right forelimb was surgically prepared. A standard lateral approach to the palpable lateralized radial head was performed. The fascial plane between the common digital extensor and the lateral digital extensor muscle was separated to expose the radial shaft. The radial nerve was identified, and a vessel loop was placed to isolate the nerve and to allow it to be retracted cranially or caudally as required to prevent iatrogenic damage. The articular surface of the radius was exposed by sharply transecting the annular ligament and joint capsule. The radial head had an abnormally convex appearance. A planned ostectomy was marked at 1.8 cm distal to the articular surface of the radius based on the preoperative CT images, however intraoperatively it appeared that the proximal portion radius would potentially contact the humeral condyle during flexion and supination. Therefore, the ostectomy was made 2.5 cm distal from the articular surface, which included the complete removal of the radial head and neck and was distal to the insertion of the collateral ligament on the radius, with an oscillating saw (Arthrex DrillSaw Sports 400). A Hohmann retractor was used to prevent injury to the ulna and saline lavage of the saw blade was continuous. The radial head and neck was removed by transecting the remaining soft tissue attachments. The cut surface of the radius was cauterized with the bipolar cautery tip and then coated in bone wax (Teknivet, BioMedtrix Zurich, Switzerland) to try to reduce the risk of excessive new bone formation. The joint capsule and the fascia were closed in a two-layer simple continuous pattern and further closure was routine. There was no attempt to imbricate tissues and there was no attempt to preserve the lateral collateral ligament attachment to the radius.

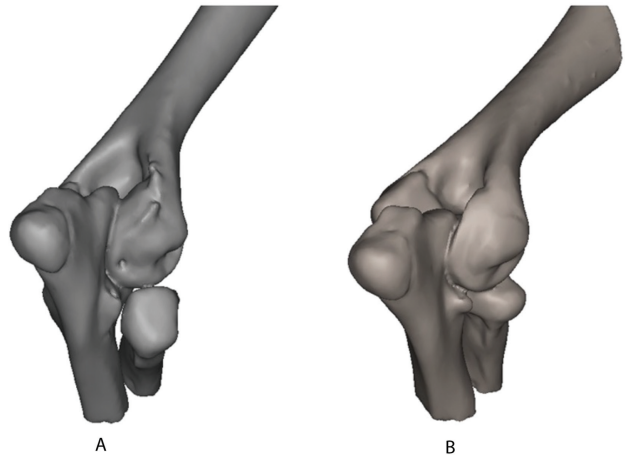

Fig. 1 The image on the left (**A**) is the caudolateral view of the RIGHT elbow rendered from the computed tomography image showing complete caudolateral luxation of the radial head. (**B**) is the left elbow which has been inverted for better comparison.

Immediate postoperative radiographs confirmed successful proximal radial head and neck ostectomy (see ►**Fig. 2**). A custom fiberglass (BSN Medical Delta-Lite Fiberglass tape), lateral splint bandage that extended just proximal to the elbow was placed. The patient recovered from anaesthesia uneventfully. The patient was discharged the next day with a Fentanyl patch (Durogesic, Janssen, Milano, Italy; 75 µg/h, transdermal, 5 d), Acepromazine (25 mg oral administration

Fig. 2 Immediate postoperative radiographs showing radial head ostectomy with no further joint support.

Fig. 3 Patient in a seated position with weight shifted to left forelimb and mild carpal valgus and external rotation of the right antebrachium at rest.

every 8 h), Gabapentin (Pfizer, Kalamazoo, MI; 300 mg oral administration every 8 h), Trazodone (100–200 mg oral administration every 8 h), and Carprofen (Rimadyl, Zoetis, Kalamazoo, MI; 37.5 mg oral administration every 12 h).

The lateral splint bandage was changed weekly and was replaced with a modified Robert Jones at 2 weeks postoperatively. The modified Robert Jones bandage was removed 1 week later (3 weeks postoperatively). The patient was restricted to room or crate rest with short leash walks with gradually increasing duration for 6 weeks postoperatively. At the 2-week recheck, the patient was weight-bearing well with the splinted bandage in place and was receiving Carprofen intermittently when its owner felt it was painful. The surgical incision healed without complication.

Follow-up

Follow-up with the patient occurred at approximately 1 year postoperatively. The patient had not been evaluated by the primary veterinarian for lameness and there are no records of any postoperative complications. The patient was highly active with the other household dog and allowed to roam freely throughout the day in a large yard. The patient primarily was allowed off-leash exercise and did not appear to be limited in its ability to exercise. Overall, the owner was happy with its progress over the last year and did not feel like their pet was painful at the time of follow-up.

At the time of recheck, the patient underwent a full orthopaedic examination, force plate gait analysis, and sedated radiographs. It was 32.4 kg and had very mild carpal valgus and external rotation of the right antebrachium at rest (see ►**Fig. 3**). It had a grade I/V lameness at the trot, as grading lameness at a walk was not possible due to patient excitement and pulling on the leash. There was no discomfort during elbow range of motion or manipulation, only a mild crepitus was appreciated. The LOAD score at this recheck was 14, placing the patient in the mild osteoarthritis category.

Force plate gait analysis was performed with a single force plate (OR6-6-1000 Biomechanics Platform with SGA6-4 Signal Conditioner/Amplifier, Advanced Mechanical Technology, Inc., Watertown, MA) using Sharon software (Sharon Software, Inc., Dewitt, MI). Velocity was measured by three photoelectric cells mounted 1 m apart. A handler guided the patient across the platform at its habitual trotting velocity. An observer evaluated each pass to confirm foot strikes and gait. A successful trial was defined by a thoracic limb hitting the platform followed by the ipsilateral pelvic limb with an average velocity of 1.69 ± 0.14 m/s at the trotting gait. Six valid trials per limb were collected. There was a mild reduction in peak vertical force and peak vertical impulse for the right thoracic limb (9 N/kg, 1.5 N·s/kg) compared to the left thoracic limb (11 N/kg, 1.8 N·s/kg).

The patient was sedated with 0.2 mg/kg of Butorphanol (Pfizer, Kalamazoo, MI) and 5 µg/kg of Dexmedetomidine

Table 2 Sedated range of motion tests measured in degrees

	Right (degrees)	Left (degrees)
Elbow flexion	38 (36[a])	30
Elbow extension	152 (150[a])	148
Carpal flexion	76	52
Campbell's test external	25	40
Campbell's test internal	24	40

[a]Denotes measurements obtained while the patient was weight-bearing.

(Pfizer, Kalamazoo, MI) administered intravenously for completion of radiographs, muscle measurements, and range of motion. Range of motion testing including elbow flexion/extension, carpal flexion/extension, and Campbell's test (summarized in ►**Table 2**). The triceps circumference was measured bilaterally at approximately 10 cm proximal to the lateral epicondyle using a soft measuring tape. The right measured 21.9 cm and the left measured 22.5 cm, showing a slight asymmetry. Radiographs revealed osseous remodelling of the previous right radial head ostectomy site with progressive mineralization of osseous fragments within the proximal antebrachial soft tissues. There was progressive degenerative osteoarthritis of the right humeroulnar joint and mild osteoarthrosis of the right antebrachiocarpal joint (see ►**Fig. 4**). Radiographs also found disuse atrophy of the right thoracic limb musculature compared to the left and a persistent mild radial procurvatum.

Fig. 4 One-year postoperative radiographs of previously operated (right) elbow.

Discussion

Radial head and neck ostectomy without concurrent elbow stabilization has been suggested, with the caveat that elbow stability may be reduced.[7] In this case, no attempt was made intraoperatively to improve elbow joint stability following ostectomy including removal of the radial insertion of the lateral collateral ligament. At 1-year follow-up, the operated elbow had more lateral stability than the normal elbow (indicated by the reduced angles of rotation on Campbell's test) and the patient had resumed a normal lifestyle. The use of a postoperative lateral splint bandage for 2 weeks had an unknown impact on joint stability. In a case report of a radial head ostectomy in an English Bulldog by Garcia and colleagues (2021), there was no lateral collateral ligament reconstruction or augmentation. They reported that the Bulldog had a normal range of motion of the elbow at 3 years postoperatively.[17] Follow-up of more cases is required to draw definitive conclusions, but the findings in our case and the report by Garcia and colleagues (2021) both suggest that the concurrent intraoperative stabilization that has been previously reported may be superfluous.[8] In this case, a short-term (2 weeks) splint bandage promoted sufficient soft tissue healing and fibrosis to prevent destabilization of the elbow joint.

The outcome of this case, using a validated client reporting system, showed a reduction in LOAD score (21 preoperatively compared to 14 postoperatively) correlating to a reduction from severe osteoarthritis to moderate. This is contrary to the radiographic findings which showed mild progression of osteoarthritis of the humeral–ulnar joint and the development of mild antebrachiocarpal joint osteoarthritis. The force plate data correlated with our clinical findings of mild right thoracic limb lameness. Without a prospective randomized control trial, it is impossible to know if this level of lameness and if the progression of osteoarthritis would be similar if no surgery had been performed, however, the reduction in LOAD score, which reflects the clinical effects of osteoarthritis, supports a benefit of surgery to the patient.

It has been stated that radial head and neck excision cases have poor outcomes unless additional joint stabilization is performed, however, this case shows that a successful outcome can be achieved.[2] Radial head preserving procedures as outlined in ►**Table 1** have various outcomes, and many report minor complications of lameness, decreased ROM, and limb atrophy, similar to this case. Using various implants for stabilization introduces the potential for infection and implant failure, possibly leading to further surgery to address such complications. Radial head-saving procedures require advanced surgical planning, meticulous surgical technique, and advanced equipment, plus strict postoperative confinement. Radial head and neck excision offers a simple and relatively low-cost option that comparatively requires less advanced surgical skills and surgical equipment. Whilst postoperative confinement to some degree is required to allow healing of the surgical site, the strictness and length of rest are reduced compared to radial head-saving techniques.

Whenever an ostectomy is performed on a skeletally immature patient, there is a risk of bony regrowth. In severe cases, if this impinges on the humerus or ulna, this may require surgical resection. Some bony regrowth was observed in this

patient despite attempts intraoperatively to prevent this (resection of the radial neck, cauterization of the cut surface, and placement of bone wax on the cut surface). The risk of bony regrowth should be considered when deciding the length of ostectomy, follow-up monitoring, and client expectations. Similar complications may be observed in young dogs that undergo a femoral head and neck excision, although Off and Matis (2010), found little correlation between osteoproliferation toward the joint space and resulting lameness.[18]

Congenital luxation of the radial head continues to challenge orthopaedists due to the degree of difficulty in restoring a complex joint and the lack of consensus on a gold standard procedure. The radial head and neck ostectomy is a salvage procedure that can be done with basic surgical skills and in this case, reduce the level of pain and lameness observed. This procedure is ideal for clients who may be financially restricted, not able to follow-up regularly because of hospital location, or potentially without an advanced surgical team. A radial head ostectomy can be considered in an older animal (>5 months) where a convex radial head may reduce the likelihood of a positive outcome from radial reduction techniques.

As this is just one case study, further investigation is needed to accurately assess the long-term success of radial head and neck ostectomy. Ideally, a case–control study using LOAD scoring and force plating to investigate the various surgical techniques compared to a controlled case would provide the strongest evidence of success.

Funding
Funds from the University of Wisconsin-Madison Veterinary School Discretionary Research funding account of Dr Susan Schaefer were used to pay for the one-year postoperative examination, radiographs, and gait analysis.

Conflict of Interest
None declared.

Acknowledgments
The authors are grateful for permission to use the LOAD index, a clinical metrology instrument developed and owned by the University of Liverpool and exclusively distributed by Elanco Animal Health, for the evaluation of osteoarthritis in this study.

References

1 Kene ROC, Lee R, Bennett D. The radiological features of congenital elbow luxation/subluxation in the dog. J Small Anim Pract 1982; 23(10):621–630
2 Dassler C, Vasseur PB. Elbow luxation. In: Slatter DG, ed. Textbook of Small Animal Surgery. 3rd ed. Philadelphia: W.B. Saunders Company; 2003:1919–1927
3 Temwichitr J, Leegwater PAJ, Auriemma E, et al. Evaluation of radiographic and genetic aspects of hereditary subluxation of the radial head in Bouviers des Flandres. Am J Vet Res 2010;71(08): 884–890
4 Clark KJ, Jerram RM, Walker AM. Surgical management of suspected congenital luxation of the radial head in three dogs. N Z Vet J 2010;58(02):103–109
5 Chong WL, Davey J, Jermyn K, Sul R, Michelsen J. Successful management of congenital radial head subluxation in a juvenile dog using ultra-high molecular weight polyethylene suture toggle. VCOT Open. 2022;05(02):e103–e105
6 Kim J, Song J, Kim SY, Kang BJ. Single oblique osteotomy for correction of congenital radial head luxation with concurrent complex angular limb deformity in a dog: a case report. J Vet Sci 2020;21(04):e62
7 DeCamp C. Brinker, Piermattei and Flo's Handbook of Small Animal Orthopedics and Fracture Repair. 5th ed. Elsevier; 2016
8 Heidenreich DC, Fourie Y, Barreau P. Presumptive congenital radial head sub-luxation in a shih tzu: successful management by radial head ostectomy. J Small Anim Pract 2015;56(10): 626–629
9 Verdese P, Manfredini S, Formaggini L. Surgical treatment of congenital radial head luxation in a cat by ostectomy of radial head. VCOT Open 2022;05(01):e1–e5
10 Spadari A, Romagnoli N, Venturini A. A modified Bell-Tawse Proceduter for surgical correction of congenital elbow luxation in a Dalmatian puppy. Vet Comp Orthop Traumatol 2001;14(04): 210–213
11 McDonell HL. Unilateral congenital elbow luxation in a Cavalier King Charles Spaniel. Can Vet J 2004;45(11):941–943
12 Harasen G. Congenital radial head luxation in a bulldog puppy. Can Vet J 2012;53(04):439–441
13 Fafard AR. Unilateral congenital elbow luxation in a dachshund. Can Vet J 2006;47(09):909–912
14 Fitzpatrick N, Yeadon R, Farrell M. Surgical management of radial head luxation in a dog using an external skeletal traction device. Vet Comp Orthop Traumatol 2013;26(02):140–146
15 Hercock CA, Pinchbeck G, Giejda A, Clegg PD, Innes JF. Validation of a client-based clinical metrology instrument for the evaluation of canine elbow osteoarthritis. J Small Anim Pract 2009;50(06): 266–271
16 Walton MB, Cowderoy E, Lascelles D, Innes JF. Evaluation of construct and criterion validity for the 'Liverpool Osteoarthritis in Dogs' (LOAD) clinical metrology instrument and comparison to two other instruments. PLoS One 2013;8(03):e58125
17 Garcia DC, Garcia LEM, Melo R, de Sá MJC. Congenital elbow luxation grade I treated by radial head ostectomy in an English Bulldog. RBCV 2021;28(01):14–19
18 Off W, Matis U. Excision arthroplasty of the hip joint in dogs and cats. Clinical, radiographic, and gait analysis findings from the Department of Surgery, Veterinary Faculty of the Ludwig-Maximilians-University of Munich, Germany. 1997. Vet Comp Orthop Traumatol 2010;23(05):297–305