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Treatment of Congenital Elbow Luxation using the Ilizarov Technique of Distraction Osteogenesis in a Dog

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Abstract : A 6-month-old, 4.1 kg female Dachshund dog presented with intermittent non-weight bearing lameness of the right thoracic limb. Radiographs revealed caudolateral luxation of the right radial head and a shortened right ulna compared to the contralateral limb. Bone lengthening by distraction of the ulna using the Ilizarov technique was performed following ulnar osteotomy. The rate of distraction was 1.5 mm per day, adjusted a total of 3 times daily for a total distraction distance of 10 mm. The Ilizarov fixator was removed four weeks after surgery. The patient showed knuckling due to radial nerve injury that occurred during limb-lengthening. Corrective osteotomy was performed using a plate and pin for the luxation and deformity of the right radial head. The luxation of the radial head was successfully reduced following surgery. However, the knuckling persisted after surgery. Rehabilitation for radial nerve injury was performed using heat therapy, massage, a passive range of motion exercises, water treadmill exercises, neuromuscular electrical stimulation, leash-walking, and acupuncture. 15 months after surgery, the patient showed satisfactory weight-bearing ambulation without recurrence of lameness. The use of the Ilizarov technique is a good surgical option for the treatment of a patient with congenital elbow luxation.

Key words **:** Ilizarov technique, radial head, knuckling, radial nerve injury, rehabilitation.

Introduction

Congenital elbow luxation (CEL) is polygenic genetic disease of dogs characterized by bony malpositioning that occurs at a young age, resulting in incongruent joint surfaces. It can occur either unilaterally or bilaterally (4,9,13). The underlying cause of CEL remains unknown. Some reports suggest that it may be due to hypoplasia or aplasia of the elbow ligaments, particularly the medial collateral ligament (3,4,14). Three types of CEL are recognized: humeroradial, humeroulnar, and combined humeroradial and humeroulnar.

The humeroulnar type of CEL, primarily observed in Dachshunds, is caused by lateral or caudolateral luxation of the radial head, while the ulna is located at a relatively normal position (3,4,14). This type may occur secondary to trauma to the distal ulnar growth plate at an early age, resulting in a shortened ulna. The radius continues to grow, eventually resulting in asynchronous growth of the radius and ulna (4,6). Mild cases can be manually reduced or treated conservatively and monitored with serial radiographic evaluation. Surgical intervention is recommended in cases with clinical symptoms such as pain, progressive subluxation of the elbow, or evidence of bony remodeling. Surgical options include transarticular pinning, bone plating, or external fixation with an Ilizarov apparatus (4).

The Ilizarov technique is useful when bone shortening is present because it increases the length of the bone by distracting the separated bone following corticotomy (2,8,15, 16,19). This technique also has the advantage of preserving the periosteum and the intra-medullary blood supply. There are actually cases of CEL that have been successfully calibrated using an Ilizarov apparatus to match the natural congruity of the elbow joint (19). The Ilizarov technique has frequently been used to treat large segmental bone loss in the lower extremities (16,18). Use of the Ilizarov technique with gradual distraction is a safe, adjustable, and stable method of treating elbow deformities (17). However, complications occur frequently during the bone lengthening process (15,16). These complications include pain, pin track infections, and nerve injury (2,8,15,16,17).

Nerve injury is a serious complication associated with bone lengthening that can be addressed by rehabilitation (1,11,20).

Rehabilitation methods include heat therapy, massage, passive range of motion (PROM) exercises, neuromuscular electrical stimulation, water treadmill exercise, and acupuncture (1,20). These rehabilitation methods can improve recovery of the neuromuscular response, range of motion, and muscle strength by stimulating the affected nerve (11).

The purpose of this case report is to describe the surgical technique and clinical outcomes of the Ilizarov technique for the treatment of a patient with CEL.

Case

A 6-month-old, female Dachshund dog weighing 4.1 kg was referred for a one-month history of intermittent non-weight bearing lameness of the right thoracic limb. On physical examination, right thoracic limb is shortening and bow.

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Fig 1. Two-view orthogonal radiographs of the right forelimb of a 6-month-old Dachshund. Caudolateral radial head luxation (arrow) is observed.

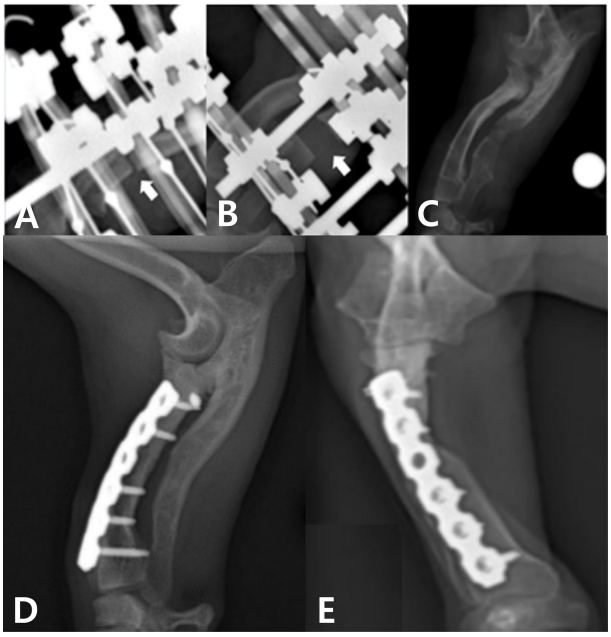

Fig 2. Postoperative radiographs of the right forelimb of a 6-month-old Dachshund with congenital elbow luxation treated with the Ilizarov technique and corrective osteotomy. Medio-lateral projection immediately postoperatively. Note the ulnar osteotomy line (arrow) prior to distraction (A). Medio-lateral projection 9 days postoperatively. Distraction was performed until the total distance was 10 mm (arrow) (B). Medio-lateral projection 6 weeks postoperatively. The Ilizarov apparatus was removed after the consolidation phase (C). Medio-lateral projection 36 weeks after corrective osteotomy surgery (D). Antero-posterior projection 36 weeks after corrective osteotomy surgery (E).

On radiographic examination, caudolateral luxation of the right radial head and a shortened right ulna compared to the contralateral limb were noted (Fig 1). The diagnosis was right elbow joint luxation. The surgical plan involved a two-stage surgical approach, the first stage consisting of distraction of the ulna using the Ilizarov technique, and the second stage involving a corrective osteotomy to achieve reduction of the radial head and resolution of the deformity.

The first surgery involved the use of an Ilizarov apparatus for limb lengthening. Distraction was performed three days after surgery. The rate of distraction was 1.5 mm per day adjusted a total of 3 times per day. Distraction was performed until the total distance was 10 mm. On the 34th day, after the consolidation phase, the Ilizarov apparatus was removed. The length of the right ulna before surgery was 86.3% of the ulnar length on the contralateral limb and was 97.2% after surgery.

A second operation was performed one week after the removal of the Ilizarov apparatus. Corrective osteotomy for the radial deformity, reconstruction of the damaged collateral ligament using an anchor, and temporal fixation of the radius and ulna using k-wire were performed (Fig 2). Luxation of the radial head was corrected following these methods to fix the elbow joint incongruity. When comparing the radiographs before and after surgery, the ulna was distracted, the radial head that was luxated caudolaterally was reduced, and the elbow congruity was well-adjusted.

After distraction following the first surgery and application of the Ilizarov apparatus, knuckling occurred. The knuckling persisted after the second surgery for the radial head luxation operation.

Because the symptoms occurred following distraction, they were thought to be due to radial nerve injury due secondary to distraction. Since deep pain remained present, and there was an appropriate sensation response to the stimulation, the injury was considered neurapraxia due to distraction.

Therefore, based on the clinical signs of nerve damage, rehabilitation was planned (Fig 3). In stage 1, from day 0 to 14 of rehabilitation therapy, the goals were to increase ROM and control swelling and edema. In stage 2, from day 15 to 50 of rehabilitation therapy, the goals were to induce weight-bearing and increase muscle mass. In stage 3, when a patient starts to play a certain amount of affected leg, the patient exercises weight on the forelimb, inducing the patient to stand still or to use the leg when walking slowly.

Cryotherapy, heat therapy and PROM therapy were started first, followed by NMES, swimming, acupuncture, massage and leash-walking beginning on day 15 of rehabilitation therapy. Beginning on day 50 of rehabilitation therapy, when the patient started to ambulate a little better with her affected leg, stairs, three-leg standing and balancing exercises were added. During rehabilitation, the circumferences of the right and left humerus were measured, confirming that the differences between the two were definitely reduced. The range of motion of the elbow was 128 degrees on the right side after surgery and 116 degrees on the left side. After four weeks, when the gait was evaluated, the patient was intermittently lifted up. The next time the gait was evaluated after 12 weeks of rehabilitation, the patient's ability to walk was improved.

Forty-eight weeks after surgery, the patient had persistent lameness that was not attributed to a pathologic problem of the elbow joint but rather an issue with the shoulder. On physical examination, the patient felt pain on the right shoulder and instability was present when the shoulder was moved. Based on physical examination and ultrasound, the

Fig 3. Rehabilitation for the radial nerve injury was performed with heat therapy, massage, passive range of motion exercises, water treadmill exercise, neuromuscular electrical stimulation, leash-walking, and acupuncture. Swimming (A). Acupuncture (B).

patient was suspected to have medial shoulder instability. Radiographic examination at the time showed that the elbow congruity was well-adjusted, and there was no evidence of degenerative joint disease. The condition improved with 4 weeks of pain medication and rehabilitation. The patient has been doing well throughout 15 months of follow-up.

Discussion

In a CEL with complete luxation, surgical correction is challenging, but in this case, the Ilizarov technique was able to effectively reduce the luxation with successful results. Before surgery, the length of the ulna was short, and considering the fact that the patient was a growing puppy and the ulnar length would be shorter when the ostectomy was performed, the Ilizarov technique was utilized to minimize this imbalance. The Ilizarov technique was used to increase the length of the ulna and make it easier to correct the luxation of the radial head.

Therefore, distraction was done to increase the length of ulna. It is recommended to distract at a rate of 1 mm per day because a rate exceeding 2 mm per day may cause neuropathies. Premature consolidation can occur if the latency is too long, and poor bone regeneration can occur if it is too short, leading to nonunion.

In this case, distraction osteogenesis was performed according to all three standards. The length of the ulna was increased by 8 mm after surgery, corrective osteotomy was used to correct the radial head, and overall elbow congruity was good.

However, distraction to within the normal range can cause radial nerve injury due to complications. In one human study, nerve damage occurred in 9.3% of 814 limb lengthening procedures. Of these, 84% reported damage during distraction (5,15). Eventually, distraction osteogenesis to within the normal range can lead to complications including nerve injury.

Therefore, monitoring for sensory function, motor function, and deep pain sensation during lengthening is required. Early detection can result in less damage and faster patient recovery (15). In this case, the patient was monitored during distraction, and at the end of distraction, there were no issues with deep pain sensation or and sensory function, but knuckling occurred and was thought to be neurapraxia.

In a human study, patients with peripheral nerve damage were treated with electro-acupuncture, and all patients with neurapraxia recovered completely. Two of the four patients with axonotmesis recovered completely, one recovered only moderately, and the other had no functional recovery. There was also one patient with neurotmesis who showed no improvement with electro-acupuncture (5,7,12).

Conclusion

In this case report, Ilizarov technique was performed for the treatment of a patient with congenital elbow luxation. Ilizarov technique was able to effectively reduce the luxation with successful results. After distraction with Ilizarov technique, complications such as nerve injuries can occur and can be successfully treated with rehabilitation therapy.

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