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Elbow Arthrodesis with bone Autograft for the Management of Gunshot Fracture in a Dog

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Abstract : A 6 year-old intact male hound cross dog, weighing 23 kg, was presented to the Teaching Animal Hospital, Chonbuk National University with the history of gunshot wound at the left elbow joint. Survey radiographs of the affected elbow revealed the presence of a metallic bullet caudal to the olecranon processes and comminuted fracture of the proximal radius and ulna. The first treatment strategy included removal of the bullet and fixation of the radius and ulna using separate bone plates, bone screw, K-wire and surgical wire, was failed. The second treatment strategy included olecranon osteotomy and rigid immobilization of the elbow joint with a bone plate applied to the caudal aspect of the humerus and ulna along with autogenous bone grafts collected from the 13th rib. The optimal angle of the joint following arthrodesis of this case appeared to be 130°. This resulted in improving the case but after 60 weeks the plate was bent and there was exudation from the wound. The third treatment strategy was the same with the second except for that the bone autografts were collected from the proximal metaphyses of the ipsilateral humerus. This resulted in a successful arthrodesis 6 weeks after the surgery. Elbow arthrodesis with bone autograft resulted in acceptable function, but abnormal gait remained in the dog due to mechanical interference with the movement of the joint.

Key words: Elbow arthrodesis, autograft, dog, gunshot fracture

Introduction

Orthopedic disorders of the elbow are common. In small animal orthopedics, salvage operations for a nonfunctional joint include excision arthroplasty and total joint replacement with an implant, but the only practical option currently being widely used for the elbow is arthrodesis[5,10]. Arthrodesis is the removal of motion from a joint, by fusion of the opposing surfaces into a solid bony unit[10]. Elbow arthrodesis is a moderately disabling procedure that should be considered as an alternative to amputation[6]. The most common indications for the arthrodesis of elbow joint are degenerative joint disease secondary to ununited anconeal process, fragmented coronoid process, osteochondrosis dissecans, premature closure of the radial and ulnar growth plates, chronic luxation or subluxation (traumatic and congenital), irreparable articular fracture, nonunion and malunions, septic arthritis and peripheral nerve injuries[5,6,10,11]. However, the procedure is not performed commonly due to technical difficulty and significant alterations in gait[6].

A number of fixation methods for elbow arthrodesis have been described[6,12-14]. However, most authors recommended the application of bone plate and screws along with the caudal aspect of the humerus and ulna as the primary fixation device[3,6,12-15]. Because of the superior stability provided by plates, they are the most effective of the above mentioned equipment in leading to successful arthrodesis[10].

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The angle of fusion is very important and can be predetermined by measuring the opposite leg[4,10]. The average angle of the elbow is approximately 130° to 150°. Many authors advise arthrodesis of the elbow at a functional angle, but specific recommendations range from 110° to 150°[3,10,14]. The angle of fusion is critical since excessive extension will result in excoriation of the dorsum of the digits. Circumduction of the limb when walking and carriage of the limb at faster gaits to be expected[6].

Autogenous cancellous bone grafts are used in an arthrodesis to stimulate osseous union and to shorten healing time, hence joint fusion occurs before implant loosening or failure. Cancellous bones may be packed into the joint cavity between the denuded joint surfaces and into voids and defects around the arthrodesis and under the plate after stabilization is complete[9,10]. The proximal metaphyses of the ipsilateral humerus and tibia are good collection sites of bone grafts. Some additional cancellous bone may be harvested from resected articular condyles, such as the distal femur[9]. In cats and small dogs, a composite corticocancellous graft from ilium or rib, cut up into small fragments, is the next best choice for graft material when insufficient cancellous bone exists[9,10]. Fresh autogenous bone grafts promote new bone formation by introducing osteoblasts and osteogenic precursor cells (osteogenesis), by release of growth factors that induce osteogenic differentiation in mesenchymal tissue at the graft bed (osteoinduction), and by acting as a scaffold on which new bone can be deposited (osteoconduction)[9].

To our knowledge, clinical reports of elbow arthrodesis with autogenous bone grafts after gunshot fracture of the radius and ulna have not been published. The purpose of this

study was to evaluate the surgical technique, complications and final functional outcome of elbow arthrodesis with bone autograft for the management of comminuted fracture of the radius and ulna in a dog.

Case

History

A 6 year-old intact male hound cross dog, weighing 23 kg, was presented to the Teaching Animal Hospital, Chonbuk National University with the clinical history of gunshot wound at the left elbow. Severe lameness was noticed on left fore limb with bleeding from the lesion.

Clinical Examination

On admission the dog was found unthrifty. The subcutaneous tissues and muscles surrounding to the wound were burnt. The rectal temperature was 38.8°C, pulse rate 140/min and respiratory rate 40/min. Radiograph of the affected elbow revealed the presence of a large metallic bullet (99.5 gm) caudal to the olecranon processes and comminuted fracture of the proximal radius and ulna (Fig 1).

The hematologic abnormalities included low PCV (33%; reference range 37-55%) and low Hb (12.5 mg/dL, reference range 15.0 mg/dL). The abnormal serum biochemical findings included hypoprotenemia (3.0 gm/dL, reference range 3.6-5.2 gm/dL) and hypoalbuminemia (0.70 gm/dL, reference range 2.3-3.8 gm/dL). No abnormalities were noticed in blood gas analysis and urinalysis.

Diagnosis

Diagnosis was made as comminuted fracture of the proximal radius and ulna on the basis of the clinical findings and radiographic examinations.

Treatment

The dog was premedicated with atropine sulphate 0.05 mg/kg S.C. and induction of anesthesia was performed using thiopentone sodium 20 mg/kg I.V. Anesthesia was maintained with enflurane and oxygen delivered through a cuffed endotracheal tube.

Fig 1. Lateral radiographic projection of the left elbow joint showing comminuted fracture of the proximal radius and ulna and the presence of a metallic bullet just caudal to the olecranon process.

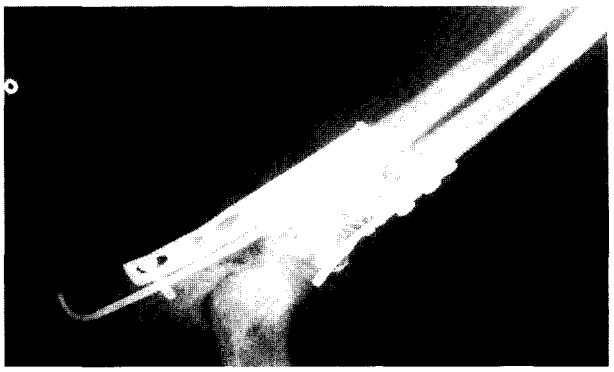

Fig 2. Lateral view of the elbow showing the fixation of the radius and ulna using separate bone plate and bone screw, K-wire and surgical wires.

The area of the elbow joint was surgically prepared. The patient was positioned on dorsal recumbency and draped. A lateral incision was made to get sufficient space and blunt dissection of the muscles and tissues were performed to expose the radius and ulna and to visualize the bullet. Debridement of the burnt tissues were performed. Hemostasis was done using electric cauterizer and ligatures. There was comminuted fracture of the proximal radius and ulna. The metallic bullet was found just caudal to the olecranon processes. The bullet was removed; the radius and ulna were separately fixed using bone plate and bone screw, K-wire and surgical wires (Fig 2). Radiograph taken 1 week after the surgical correction revealed resorption of bones at the fracture site which was worsening gradually.

Therefore, elbow arthrodesis was re-performed to stop the lesion worsening with the same anesthetic protocol. The bone screws, bone plates, K-wire and surgical wires were removed. Osteotomy of the olecranon process was performed. The ulnar nerve was isolated and retracted to avoid iatrogenic injury. The anconeus muscle and lateral joint capsule were incised to expose the humeroradial joint. Articular cartilage was removed from the joint surface and temporary fixation of the arthrodesis was maintained with a Kirschner wire. A bone plate was contoured and applied to the caudal surfaces of the humerus and ulna. Compression across the joint was performed by placing one screw as a lag screw (Fig 3).

Autogenous corticocancellous bones collected from 13th rib were harvested in and around the arthrodesis site. The wound was closed in a usual manner. The limb was immobilized in a spica splint for four weeks with exercise restriction. Sixty weeks after the surgical correction, there was sudden bending of the bone plate with exudations from the wound (Fig 4).

To correct this problem, the third surgery was performed using replacement of the bone plate and re-arthrodesis of the elbow (Fig 5).

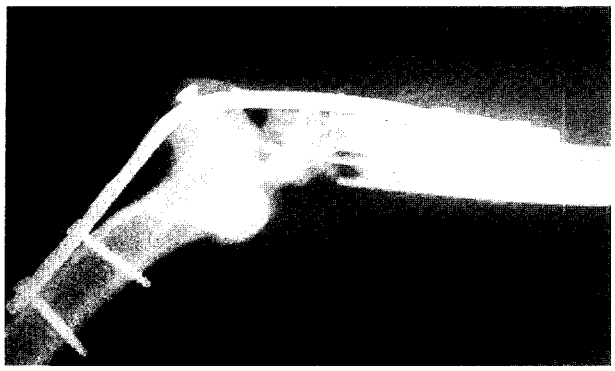

Fig 3. Radiograph taken after 1st elbow arthrodesis.

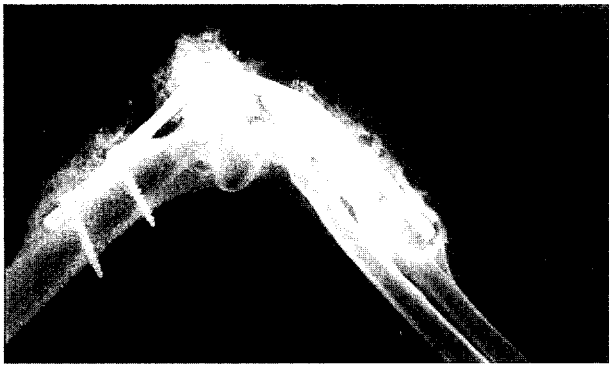

Fig 4. Radiograph taken sixty weeks after elbow arthrodesis showing bending of the bone plate and accumulation of exudates.

Fig 5. Lateral radiograph taken after 2nd elbow arthrodesis.

For autogenous bone grafts, bone fragments collected from the proximal metaphyses of the ipsilateral humerus were harvested in and around the arthrodesis site. And then the wound was closed in a usual manner. The optimal angle of the joint following arthrodesis appeared to be 130°. The limb was immobilized in a spica splint for four weeks with exercise restriction until radiographic fusion was evident. Post operative treatment was given with cephalothin sodium 30 mg/kg I.V and dexamethason 2 mg/kg for 1 week.

Discussion

Healing of the fracture after surgical correction was monitored by physical examination and radiography. Radiograph of the elbow taken 1 week after the first surgical correction revealed resorption of bones at the fracture sites and this condition was worsening gradually, and there was malunion of the fracture ends.

After the second surgery (arthrodesis along with autograft) the condition was gradually improving but the progression was very slow. Radiograph of the elbow taken immediately after the surgery was compared with the subsequent radiographs taken at 1, 5, 10, 20, 30, 40, and 50 weeks after the surgery for evaluating healing process and monitoring the angle of the joint. However, all of these radiographs revealed gradual progress and osteogenesis at the fracture sites and the angle appeared to be 130°. In spite of no detectable instability on palpation and physical examinations, the animal was incapable of full pain-free weight bearing on the affected limb. Gradually the muscles became atrophied and pliable. However, 60 weeks after arthrodesis, suddenly the bone plate bent and there was exudation from the wound. A third surgery was performed; the plate was replaced with a new one and rearthrodesis was done along with bone autografts at the fracture site. The radiographs taken at 2 and 3 weeks after the surgery revealed osteogenesis and heeling at the fracture site and the prognosis seemed to be good. Radiographs taken at 4 weeks after the surgery revealed a complete healing and arthrodesis (Fig. 6).

The animal began partial weight bearing on the limb after 2 weeks and was capable of full pain-free weight bearing after 8 weeks. No instability was detected on palpation. The arthrodesis became full functional except for mild lameness on the affected limb while walking.

The malunion of the fractured ends and resorption of bones after the first surgery might be due to inter-fragmentary movements by the movement of the elbow joint[9]. The disruption of blood supply to the injured area caused by the course of the bullet also thought to delay healing of the wound and malunion of the fractured ends[1,2]. The disruption of blood

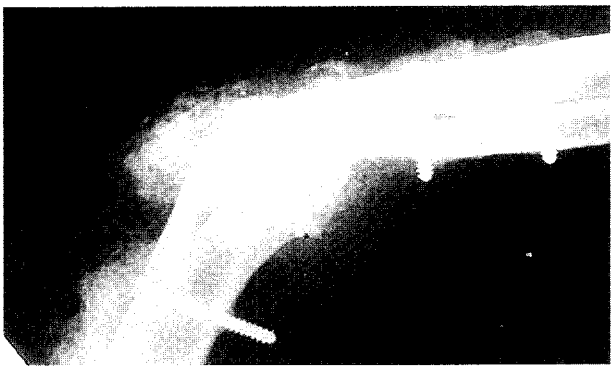

Fig 6. Lateral radiograph taken four weeks after 2nd elbow arthrodesis showing a complete healing.

supply also might contribute to atrophy of the muscle and failure of the first arthrodesis (second surgery). The bending of the bone plate is thought to be due to weight bearing loads on the affected limb. Jonson in 1995[9] reported that the weight bearing loads and muscle contraction acting on an arthrodesis are a mixture of the compressive, tensile, bending, and torsional forces. These must be alleviated by the internal fixation; otherwise, inter-fragmentary motion may lead to bone resorption, implant loosening, loss of stability, and nonunion. Of these forces, the craniocaudal bending is the most significant in causing disruption of the arthrodesis.

The autogenous cancellous bone grafts were used to stimulate osseous union in the arthrodesis[7-10]. Cancellous bones may be packed into the joint cavity between the denuded joint surfaces and into voids and defects around the arthrodesis and under the plate after stabilization is complete. The sites for collection of autogenous bones include proximal metaphyses of the ipsilateral humerus and tibia, resected articular condyles of the femur[9]. A composite corticocancellous graft can be collected from the ilium or rib[9,10]. However, in this case, corticocancellous grafts were collected from the 13th rib at the first surgical attempt and from the metaphyses of the ipsilateral humerus at the second attempt respectively. It has been reported that fresh autogenous bone grafts promote new bone formation by introducing osteoblasts and osteogenic precursor cells (osteogenesis), by release of growth factors that induce osteogenic differentiation in mesenchymal tissue at the graft bed (osteoinduction), and by acting as a scaffold on which new bone can be deposited (osteoconduction)[7-10]. With cancellous bone grafting, osseous union of arthrodesis occurs in 4 to 8 weeks, whereas without a graft, union occurs in less predictable and takes in excess of 12 weeks[7-9].

Conclusion

A complicated fracture of the elbow joint by gun shot was surgically corrected using arthrodesis with autogenous bone graft. In this case study, we found that the healing process of fracture was delayed by malunion of fracture. However, this study found that autogenous bone grafts stimulated osseous union in the fracture ends. This case study reported a successful elbow arthrodesis using complete immobilization of the joint with autogenous bone grafts.

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총상 골절 개에서 자가골 이식과 주관절 고정술

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요 약 : 체중 23 kg, 나이 6세된 수캐 잡종 사냥개가 왼쪽 주관절에 총상을 입어 전북대학교 수의과대학 동물병원에 내원하였다. 방사선 사진에서 요골 척골 근위부에 복잡골절과 주관절 돌기 후방에 금속성 탄환이 발견되었다. 첫 번째 외과처치는 탄환을 제거하고 bone plate, bone screw, K-wire등을 이용하여 정복 고정하였으나 실패하였다. 두 번째 시도는 주관절 고정술과 13번째 늑골로부터 얻은 자가골을 이용하여 결손부를 충진 하였다. 결과가 만족스럽지 못하여 자가골 재이식과 3번째 수술을 실시하여 주관절의 안정된 고정상태를 유지 할 수 있었다. 60주가 지난 현재 평상시 활동에는 커다란 문제점이 없지만 속보 혹은 뛰는 경우 관절 고정술을 실시한 다리를 들고 세 다리만 사용하는 아쉬움이 있다.

주요어 : 관절고정술, 골이식, 골잡골절, 주관절 돌기