Animal and Veterinary Sciences
2022; 10(6): 170-173
http://www.sciencepublishinggroup.com/j/avs
doi: 10.11648/j.avs.20221006.11
ISSN: 2328-5842 (Print); ISSN: 2328-5850 (Online)

Treatment of a Radio-Ulnar Atrophic Pseudoarthrosis in a Toy Poodle Using an Autologous Coccygeal Vertebrae Transfer and Plate Fixation

Giuseppe Bartoletta[1, *], Franco Pizzirani[1], Stefano Pizzirani[2]

[1]Clinica Veterinaria Europa, Firenze, Italy

[2]Cumming School of Veterinary, Medicine Tuft University, Boston, USA

Email address:

giuseppebartoletta@gmail.com (Giuseppe Bartoletta)

[*]Corresponding author

To cite this article:

Giuseppe Bartoletta, Franco Pizzirani, Stefano Pizzirani. Treatment of a Radio-Ulnar Atrophic Pseudoarthrosis in a Toy Poodle Using an Autologous Coccygeal Vertebrae Transfer and Plate Fixation. *Animal and Veterinary Sciences*. Vol. 110, No. 6, 2022, pp. 170-173. doi: 10.11648/j.avs.20221006.11

Received: July 26, 2022; **Accepted**: August 16, 2022; **Published**: January 10, 2023

Abstract: Description of the treatment of a radio-ulnar atrophic pseudo-arthrosis in a one-and-a-half-year-old female toy tramp dog. Due to a domestic trauma the patient suffred a radio-ulnar fracture. Unfortunately at the time of the first visit we were not in possession of the patient's medical record and for this reason we did not know the evolution of the previous surgical revision. The owner reports that at another centre, the subject underwent three osteosynthesis procedures (osteosynthesis with radio-ulnar intramedullary nails, plate fixation and external circular fixator), with negative results. After a long consultation with the owner it was decided to perform a surgery to restore the bone radius and ensure good mobility. Our procedure included debridement and canalisation of the bone stumps, harvesting and grafting of the coccygeal VII vertebra, autologous spongy bone grafting, osteosynthesis with VCP1.5/2.0 mm plate and 1.5- and 2.0-mm cortical screws. Clinical and radiographic evaluation were carried out regularly, during which we decided to remove some screw in order to achieve an implant dynamization. At weeks 7 and 16 four screws were removed. At week 60 the plate was removed and further controls at weeks 64 and 90 confirmed anatomical and functional healing. No wound or bone healing complication were reported.

Keywords: Atrophic Pseudoarthrosis, Vertebrae Transfer, Radio-Ulnar Fracture, Plate Osteosynthesis

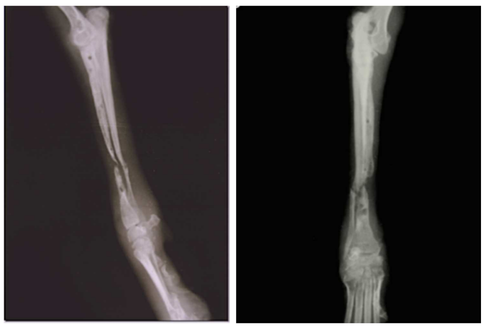
1. Introduction

The term pseudo-arthrosis defines the failure of bone healing of a fracture, with interposition of fibrous or cartilaginous tissue in the fracture site or the osteotomy [1]. Bone healing is spontaneously regulated by physiological (intrinsic) factors that may vary depending on the patient's age and/or general health status. Under certain conditions, usually related to stump instability, surgical procedures (extrinsic factors) must be associated, whose primary objective is to stabilise the fracture stumps to restore anatomical function [2]. Bone healing of a fracture, including the importance of cytokine stimulation, respect for vascular microcirculation and the fundamental need for stump stability has been described in detail in articles and reference texts [3, 4]. Fundamental concepts for a stable and functional callus include stability between cells, absence of micromovements, and adequate vascularisation [5]. These environmental conditions are interdependent and, in particular, decreased oxygen supply to the fracture site can interfere with bone formation and instead favour the deposition of cartilage tissue, leading to pseudo-arthrosis [5-7]. The detailed classification of pseudo-arthrosis is still a source of debate [8]; the one most widely used is the one proposed by Weber and Cech [9] which differentiates pseudo-arthrosis into vital and non-vital. In vital pseudoarthrosis, the failure to consolidate the bone callus is characterised by a proliferative bone reaction, with the interposition of cartilage and fibrous tissue that can be seen both radiographically and histologically. Vital pseudoarthrosis, depending on the activity of the bone callus, is distinguished into three types: hypertrophic, normothrophic, and oligotrophic. Regarding non-vital pseudo-arthrosis, they are further subdivided into dystrophic, necrotic, deficient and atrophic. According to a study conducted on 2825 cases of pseudoarthrosis [10], they were found in the radio-ulnar segment in 40.6% of cases, in the femoral in 39.5% of cases, in the humeral in 12.5% of cases, and in the tibial in 4.2% of cases. While hypertrophic pseudo-arthroses are generally easier to treat [11], atrophic pseudo-arthroses present a more complex challenge as they are poorly vascularised. In toy breed dogs they are found more in the distal radial-ulnar segment due to the deficient arborization of the metaphyseal vasculature [12].

The purpose of this report is to describe the treatment of a chronic atrophic pseudo-arthrosis in a toy breed dog, using an autologous cortical implant obtained from a coccygeal vertebra, already described for a different bone segment [13], as an alternative to other techniques (bank bone, synthetic bone, distraction osteogenesis) [14].

2. Clinical Case

A twenty-month-old whole female toy poodle weighing three kilograms was referred to our clinic for an orthopaedic consultation. Nine months before, the patient had suffered a radioulnar fracture that was initially treated with an osteosynthesis using intramedullary Kirshner wires. The first surgery was revised using a plate. After forty days, the plate was replaced by a circular external fixator. About thirty days after surgery, the implant was removed due to infection and the limb was immobilised with a rigid cast. At the time of the examination, after the bandage was removed, swelling, pain on palpation and bone instability of the fracture site were appreciated. An X-ray study under sedation, using medio-lateral and antero-posterior projections of the left forearm, showed an atrophic pseudo-arthrosis of the diaphysis of the radius and ulna with thinning of the bone stumps, loss of substance and lack of osteogenic activity (Figure 1). One of the concerns raised during the pre-surgery planning was the lack of bone tissue to restore the correct length of the bone radius. After analysing the advantages and disadvantages of viable options, including limb amputation, the client opted for an autologous bone graft. The patient underwent general anaesthesia using sedation with methadone (0.2 mg/kg) and dexmedetomidine (2 μg/kg) intramuscularly. Induction was performed with propofol (2mg/kg) intravenously. General anaesthesia was maintained with isoflurane in oxygen (1 L/min). After aseptically preparing the limb, a cranio-medial access to the radial diaphysis was performed according to standard procedure [15]. Once the fracture site was reached, the apex of both stumps was debrided with a bone forceps, removing the necrotic material and fibrous tissue surrounding the ends. Osteostixis was then performed by inserting a 1.0 mm Kirshner wire mounted on a drill (Synthes air compact drive II) into the respective bony canals, performing continuous washings with saline to avoid thermal necrosis. A surgical access was then made to the terminal portion of the tail, which had previously been sterile prepared and isolated. The seventh coccygeal vertebra was harvested, and subjected to skeletonization, removal of the articular cartilaginous surfaces and canalisation using a 0.8 mm Kirshner wire (Figure 2). To obtain a bone segment of adequate size for the recipient site prior to the surgery, the length of the contralateral radius and the space between the bone stumps of the fractured radius were measured, resulting 10.2 cm and 1.6 cm (16% of the entire length of the radius), respectively. During the surgery, with the help of a Castroviejo Caliper, the numerical figure was reported on the vertebral body and an additional apical ostectomy was performed using an oscillating saw (Synthes air 70 compact Drive II"). Once the vertebral graft was inserted between the stumps, the fracture was realigned and stabilised by applying a cuttable plate (Veterinary instrumentation) 1.5/2.0 mm - nine holes, placing three 1.5 mm screws in the proximal stump, three 2.0 mm screws in the distal stump and two 1.5- and 2.0-mm screws in the vertebral graft (Figure 3).



a b

__Figure 1.__ Mid-lateral projection (a): Antero-posterior projection of the affected limb (b). The two projections were taken at the time of the first examination from which a picture of atrophic pseudoarthrosis is evident. Note the thinning of the bone stumps, the loss of substance and the lack of osteogenic activity. The holes for the screws and nails used in the previous treatments are also evident.

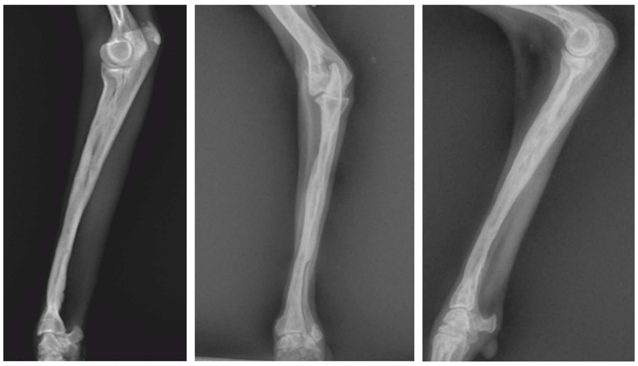
a b c d

__Figure 2.__ (a) Intra-surgery image of the coccygeal vertebra after removal from the donor site. (b) Intra-surgery image of the coccygeal vertebra after skeletisation, removal of the apical cartilages and osteostixis. (c) Intra-surgery image of the vertebra at the recipient site. (d) Intra-surgery image after osteosynthesis and subsequent autologous spongy bone grafting.

The spongy graft was obtained from the right and left humeral greater tubercle by transcortical access with a 1.8 mm drill bit and harvesting the spongy tissue with a Volkmann's spoon. It was then inserted around the transplant site. Post-surgery radiographs confirmed proper alignment of the bone radius and correct positioning of the synthesis media. After the surgery, the limb was immobilised with a modified Robert-Jones cast for eight days, replacing it every three days. At follow-up control performed twelve days after surgery, Grade I lameness was observed but pain on palpation was absent, and the wound was in good condition. At follow-up control performed twenty-five days after surgery, there was no lameness. Seven weeks after surgery, two screws in position 5 and 6 (in the proximal-distal direction) were removed after radiographic control. At sixteen weeks after surgery, two more screws in positions 3-7, in the proximal-distal direction, were removed (Figure 3). The plate with the remaining four screws was removed at sixty weeks and a rigid cast was applied to the limb for thirty days, after which a further radiographic check was made to assess the state of bone healing in correspondence of the screw holes. Sufficient osteogenic activity was observed and therefore the bandage was removed, advising the owner to limit the dog's physical activity for further two weeks. Further clinical and radiographic controls at ninety and one-hundred-and-twenty weeks after surgery, respectively, showed a good anatomical and functional result, without complications. Clinical and radiographic controls have been performed annually since then. The radiographic images of the last check-up at fifteen years can be seen in figure 4.

a b c d e

Figure 3. *(a) Post-surgery X-ray, mid-lateral projection. (b) Antero-posterior projection after partial screw removal at seven weeks. (c) Mid-lateral projection after partial removal of screws at seven weeks. (d) Mid-lateral projection after partial screw removal at sixteen weeks. (e) Antero-posterior projection after partial screw removal at sixteen weeks.*



a b c

Figure 4. *(a) Mid-lateral projection after plaque removal. (b) Antero-posterior projection of follow-up ninety weeks after surgery. (c) Mid-lateral projection of follow-up fifteen years after surgery.*

3. Discussion

The surgical treatment of atrophic pseudo-arthrosis is part of orthopaedic practice, albeit to a lesser extent than other routine procedures, and often presents a challenge to the surgeon. Although the standard surgical treatment involves debridement of the extremity of the two stumps, osteo-fixation of the spinal canal and osteosynthesis with compression of the fracture site, followed by a spongy bone graft [11], in our case the large bone defect would have led to a decrease in radius of more than 20% and would have favoured the onset of mechanical lameness [14]. The therapeutic options to restore symmetry with the contralateral limb are different (synthetic BMP [16], titanium mesh integration [17], autologous graft, homologous graft [18], distraction osteogenesis [14]). The choice of using a cortical-spongiosa graft was motivated by its structural characteristics, by all the essential components for bone formation including osteoprogenitor cells, matrix and bone morphogenetic proteins and by osteoinduction and osteoconduction activity [5, 12, 18]. Furthermore, autografts have less ability to activate the antigenic response decreasing the risk of rejection [13, 18]. The application of this technique in the radio-ulnar segment of a toy breed dog must take into account not only the small size of the bone segment but also the poor metaphyseal vascularity [12]. Furthermore, in our case, some of the holes drilled in previous operations conflicted with the screws of the plate. To remedy this problem, screws with a diameter of 2 mm were used, while the length of some of the screws, which also affected the ulnar cranial cortical bone, and the deposition of autologous spongiosa bone further favoured the development of the radio-ulnar synostosis (already visible at seven weeks after surgery). Some authors have described autologous adipose grafting between radius and ulna to prevent the development of synostosis, the cause of decreased or absent pronation and supination movements and thus lameness [19]. Numerous radiographic and clinical controls were conducted both to observe the possible development of infection of the surgical wound and the tail end tract and to monitor the state of bone healing, paying particular attention to the development of infection at the implants. The removal of the screws conducted at seven and sixteen weeks was motivated by the intention to increase the load on the bone without reducing its protection. In both cases and even after the removal of the plate, a rigid bandage was applied post-surgery for fifteen days, to increase the protection on the bone to avoid refracturing in correspondence of the screw holes.

4. Conclusion

Finally, although our surgical choice led to a satisfactory result from an anatomical and functional point of view, having only one case available it is difficult to interpret our data to compare them with other techniques described in the literature.

References

[1] Permattei DL, Flo GL, DeCamp CE (2006). Handbook of small animal orthopedics and fracture repair. 4th ed. Missouri: Saunders Elsevier. pp 170-202.

[2] Tobias KM, Johnston SA (2012). Delayed Unions, Nonunions, and Malunions. In: Veterinary Surgery Small Animal Vol I: Elsevier S. aunders. pp 647.

[3] Tobias KM, Johnston SA (2021). Delayed Unions, Nonunions, and Malunions. In: Veterinary Surgery Small Animal Vol I: Elsevier Saunders. pp 647- 655.

[4] Newton CD, Nunamaker DM. Texbook of small Animal Orthopaedics (1985): Lippincott. pp 35-41.

[5] Rhinelander FW, Philips RS, Steel WM, *et al* (1962). Microangiography and bone healing: Undisplaced closed fractured. Journal of Bone and Joint Surgery 44A: 1273.

[6] Marsell R, Einhorn TA (June 2011). The biology of fracture healing. Injury International Journal Care Injured. 42 (6) pp 551-555.

[7] Greenbaum MA, Kanat IO (1993). Current concepts in bone healing. Review of the literature. Journal of the American Pediatric Medical Association. 83 (3): 123-9.

[8] Calori GM, Albisetti W, Agus A, *et al* (2007).. Risk factors contributing to fracture non-unions. Injury International Journal Care Injured, 38S, 11-18.

[9] Weber BG, Cech O. Pseudoarthrosis (1976). Stuttgart, Vienna, Hans Huber Bern.

[10] Atilola MAO, Summer–Smith G: Nonunion fractures in dogs (1984). Journal Veterinary Orthopedics 3: 21-24.

[11] Bennett D. Complications of Fracture Healing (1998). In: Manual of Small Animal Fracture Repair and Management. Ed A Coughlan, A Miller. Cheltenham, BSAVA. pp 329-340.

[12] Welch JA, Boudieau RJ, DeJardin LM, Spodnick GJ (1997). The Intraosseus Blood Supply of the Canine Radius: Implications for Healing of distal Fractures in Small Dogs. Veterinary Surgery 26: 57-61.

[13] Yeh LS, You SM. Repair of a mandibular defect with a free vascularized coccygeal vertebra transfer in a dog (1994). Veterinary Surgery July-August.

[14] (Robert D. Welch, DVM, PhD, and Daniel D. Lewis, DVM; Distraction osteogenesis (1999). Veterinary Clinics of North America: Small animal practice: volume 29 number 5 september.

[15] Piermattei, D, Jhonson A (2004). An Atlas of surgical approaches to the bones and joint of dog and cat, IV edition: Elsevier. pp 196-198.

[16] James AW, LaChaud G, Shen J, *et al*. A Review of the Clinical Side Effect of Bone Morphogenic Protein-2 (2016). Tissue Engineering Part. B Reviews: 22 (4): 284-297, August.

[17] Zoi SI, Papadimitriou SA, Galatos AD, *et al.* Influence of a titanium mesh on the management of segmental long bone defects (2015). Veterinary and Comparative Orthopaedics and Traumatology: 28 (06): 417-424.

[18] G. Vertenten, F. Gasthuys, M. Cornelissen et al. Enhancing bone healing and regeneration (April 2010): present and future perspectives in veterinary orthopaedics. Veterinary and Comparative Orthopaedics and Traumatology.

[19] Ali Said Durmus, Emine Unsaldi. Treatment of distal radioulnar synostosis and growth deformity in a dog (2008). Olgu Sunumu; 22 (5): 299-301.