Axial Correction of Pes Varus by Transverse-Opening Wedge Osteotomy and T-Plate Fixation with Beta-Tricalcium Phosphate (β-TCP) Transplantation in Dachshunds

Yasuharu IZUMISAWA1), Takahiro SENO1), Reona ABE1), Kenjiro MIYOSHI1), Seiya MAEHARA1), Shinsuke WAKAIKI1), Tokiko KUSHIRO9), Mohammed Ahmed UMAR1), Keiko TSUZUKI1), Kazuto YAMASHITA1) and Shigeru HAYASHI2)

1)Department of Veterinary Surgery 1, School of Veterinary Medicine, Rakuno Gakuen University, Ebetsu, Hokkaido 069–8501 and 2)Hayashi Dog and Cat Hospital, Sapporo, Hokkaido 001–0910, Japan

(Received 8 June 2004/Accepted 30 November 2004)

ABSTRACT. Axial correction was performed surgically in two miniature dachshunds presenting with lateral patellar dislocation and limping caused by pes varus. Pes varus had resulted from asymmetric closure of the physis of the distal tibia. Prior to surgery, osteotomy was simulated by measuring X-ray films to determine the distance required for the wedge opening. Transverse-opening wedge osteotomy was performed on the medial side of the distal tibia, and beta-tricalcium phosphate (β-TCP) was inserted in a wedge shape into the area created by the cuneiform osteotomy. Finally, the tibia was fixed by a veterinary 1.5/2.0-mm T-plate. Both dogs were able to walk a few days after surgery, and the lateral dislocation of the patella normalized almost completely in about one month. At two months, X-ray films showed that the implant had remained in position without any dislocation, and the β-TCP had fused with the surrounding bone.

KEY WORDS: opening wedge osteotomy, pes varus, T-plate fixation.

Pes varus in dachshunds is a deformation characterized by inward turning of the distal tibia and may be seen during the growth period. The deformity is caused by asymmetric closure of the epiphyseal plate of the distal tibia [5], resulting in uneven growth of the tibia because while the lateral side of the epiphyseal plate functions properly the medial side does not. Pes varus can be either unilateral or bilateral. In its early stage, varus deformity is noticeable when the dog puts weight on the affected leg, because the center of gravity in the animal’s body shifts toward the side of the affected limb. Viewed from behind, the heel is in the valgus position. As the tibial deformity progresses, laxity of the knee joint and lateral dislocation of the patella occur, causing the dog to walk with a limp or with the affected limb lifted.

The condition known today as pes varus was first reported by Mayrhofer as metaphyseal dysplasia of the tibia [8]. Because pes varus lacks a history of trauma and is seen among siblings and family members, it is believed to be caused by an autosomal recessive gene. Johnson et al. who first used the term “pes varus,” reported favorable results from using type-II linear external fixation devices to treat pes varus in five dachshunds [6].

To treat lateral patellar dislocation and limping caused by pes varus in two miniature dachshunds, we performed axial correction by transverse-opening wedge osteotomy, beta-tricalcium phosphate (β-TCP) transplantation, and T-plate fixation. Results were favorable. Here, we report the surgical methods and outcomes.

Case 1 was a 7-month-old male miniature dachshund (long hair) that had undergone surgery for vertebral slippage four months earlier at our institution. Though exhibiting no
abnormality in the posterior half of the trunk, the dog was brought back because of gait abnormality of the right hindlimb, a condition found to be caused by pes varus. Lateral displacement of the right calcaneus was obvious, and when the right hindlimb touched the ground while the dog was walking, the entire body tilted to the right. Severity of lateral patellar dislocation of the right knee was grade 3.

In both dogs, X-ray films showed inward curvature of the distal region of the right tibia. In the right limb, the varus angle formed by the joint surface of the proximal tibia (knee joint) and the joint surface of the distal tibia (ankle joint) was 32 degrees in Case 1 and 26 degrees in Case 2, resulting in marked tilting of the body in both dogs. Along the lateral cortex, the right and left tibias differed in length by 8 mm in Case 1 and by 5 mm in Case 2. In the affected tibia, the length along the medial cortex differed from that of the lateral cortex by 5 mm in Case 1 and by 4 mm in Case 2.

Prior to surgery, osteotomy was simulated by using X-ray films (Fig. 2). The site of osteotomy was established as the center of the curvature, i.e., the point where line “o” intersected the medial cortex of the tibia. The distance (a) of the wedge-shaped opening following osteotomy and the distance (b) from point “m” (tip of the medial malleolus) to the osteotomy point were measured by simulation.

Each dog was anesthetized with GOS anesthesia. In the anesthetized dog, the hair was shaved from the center of the thigh to the toes, and the shaved area was sterilized. A 50-mm skin incision was made on the medial side of the lower thigh to expose the tibia. To locate the landmark predetermined as the site for osteotomy, the tip of the medial malleolus was identified by needle insertion, and the distance (b) was measured and marked by electrocauterity. With a pneumatic sagittal saw, we cut the tibia parallel to the joint surface of the distal tibia, leaving some of the contralateral cortical bone intact. A periosteal elevator was inserted to match the size of the ostectomy to the size (a) predetermined by simulation. Then β-TCP (Osferion, Olympus, Tokyo), an artificial bone graft, was inserted into this area in a wedge shape. A veterinary 1.5/2.0-mm T-plate (Synthes, U.S.A.) was contoured to match the medial surface of the tibia and fixed with 2.0-mm cortical screws (Fig. 3). Because the T-shaped area of the plate curved inward, care had to be taken to prevent the tips of the screws from colliding. Screw 1 was placed first. Next, to confirm the direction of screwing, a screwdriver specially designed to place hexagonal screws was squarely positioned and drilling was performed so as to assure that screw 2 would not touch the first screw.

The subcutaneous tissue was sutured with 4-0 polidiox-
and proximal joints in the affected hindlimb were almost the same as their counterparts in the healthy hindlimb.

Postoperatively, 20 mg/kg of cefazolin sodium, 5 mg of serrapeptase and 2.2 mg/kg of kalprofen were administered twice daily for seven days, and a Thomas splint was used during this period.

Both dogs were able to walk a few days after surgery. When the splint was removed, the dogs walked almost normally. The lateral dislocation of the patella normalized almost completely in about one month. At two months, X-ray films showed that no implant dislocation had occurred and that the artificial bone material had fused properly with the surrounding bone. The implant was removed four months after surgery (Fig. 4-B).

These results demonstrate, among other factors, the efficacy of internal fixation with the veterinary T-plate described here. About 15 years ago, Johnson et al. reported using type-II linear external fixation devices in treating pes varus in five dachshunds [6]. Generally, external fixation is useful in fractures accompanied by infections; fractures with small fragments; support of internal fixation; some osteotomies; delayed healing; and bone fusion failure [5]. External fixation is widely performed because the procedures involved are relatively simple. However, because the clamps and bars that hold the pins inserted into the bones are outside the body, postoperative management can be complicated and infection at the junction between the skin and the fixation devices becomes an important issue [1, 4]. Moreover, as with pes varus, when the bone fragments after osteotomy are small in volume, the thickness and number of pins that can be inserted into the bone fragments are limited, making it difficult to achieve a high degree of fixation strength. Johnson et al. overcame this problem by placing a full pin into a bone fragment parallel to the tarsal joint surface of the distal tibia and placing a half pin into the shaft from the medial malleolus [6].

The 1.5/2.0 mm veterinary T-plate used in the present cases was developed by the AO/ASIF group especially for the treatment of metaphyseal fractures in small dogs and cats and is particularly useful for the treatment of metaphyseal fractures of the distal radius [7, 9]. Compared to the T-plate used in human treatment, the veterinary plate is thicker, and the distance between the two screw holes in the head region is narrower, enabling self-compression. Advantages of bone plate fixation are that the risk of postoperative infection is low because the plate is embedded in the bone and that the affected limb can be used soon after surgery without more extensive postoperative care than external fixation [2].

Results of the present cases bear out not only the usefulness of internal fixation but also the validity and practicality of preoperatively calculating the osteotomy site and other crucial measurements from the X-ray films. Although intraoperative X-ray fluoroscopy can be used for this purpose, it complicates the surgical procedures somewhat. In the present cases, since the major calculations were predetermined, needle insertion could pinpoint the tip of the medial malleolus and the surgical team were then free to concentrate on the procedures themselves, without having to stop the meticulous operation for the sake of making measurements. When severing theibia, caution must be exercised to avoid damaging the fibula, for the fibula can act as a splint for the tibia after surgery. Furthermore, the tibia must be cut so that there is some lateral cortex remaining. This prevents tibial displacement during plate fixation and makes it possible to open the osteotomized surface in a fan shape, with the lateral region of the tibia as the turning point.

In transverse-opening wedge osteotomy, a full pin is inserted into the distal bone parallel to the joint surface of the distal tibia. Adjustment is made to position the pin parallel to the joint surface of the proximal tibia or, alternatively, to match the angle formed by the pin and the joint surface of the proximal tibia (measured preoperatively) to the angle formed by the pin and the osteotomized surface (measured during surgery) [6]. In the present cases, the length of the wedge opening was determined preoperatively by measuring an imaginary line on the X-ray films, then the osteotomy was made to match this length. In cases in which the tibia is surrounded by much soft tissue, this technique is easier, more accurate and more practical.

A third contributing factor in the favorable outcomes of the dogs reported here is the use of artificial bone material as the implant. Generally, autologous cancellous bone is used to fill an area opened up by osteotomy, but in the present cases the artificial bone material β-TCP was highly efficacious in facilitating the bone remodeling, as shown by the follow-up X-rays. The use of artificial bone eliminates the need for additional surgical invasion associated with the harvesting of autologous cancellous bone, thus potentially shortening surgery time [10]. The β-TCP used in the present cases fused with the surrounding bone in about two months. This result is in agreement with other reports that the bone conduction of β-TCP is high and that β-TCP is eventually absorbed and replaced by autologous osseous tissue [3, 11].

Finally, in the two dachshunds treated here for pes varus, X-ray films taken after surgery confirmed that the desired angle was achieved and that morphologically the body of the tibia as well as the proximal (stifle) and distal (tarsal) joints of the tibia in the affected hindlimb nearly equaled those in the healthy hindlimb. In the light of the outcomes seen in these dogs, we conclude that axial correction was achieved in the affected hindlimb and that this axial correction resulted, in turn, in the reversal of the patellar dislocation in spite of the absence of surgical correction for the displacement. The patella had been located lateral to the
trochlea before surgery but was positioned properly on the trochlea one month after surgery. Corrected skeletal alignment of the distal femur and the proximal tibia resulted from the joint angle correction following the open-wedge osteotomy, thus achieving structural adaptation of the surrounding soft tissue. In conclusion, transverse-opening osteotomy coupled with the artificial bone $\beta$-TCP implant and veterinary T-plate fixation provides an effective method of repairing pes varus in small dogs, with minimal surgery time and minimal aftercare.

ACKNOWLEDGEMENT We wish to thank Professor Nell Kennedy (Department of Biomedical English) for her excellent assistance.

REFERENCES