Results of single-session bilateral triple pelvic osteotomy with an eight-hole iliac bone plate in dogs: 95 cases (1996–1999)

Frank Borostyankoi, DVM; Robert L. Rooks, DVM, MS, DACVS; Calvin N. Kobluk, DVM, DVSc, DACVS; Ann L. Reed, DVM, MS, DACVR; E. Travis Littledike, DVM, PhD

Objective—To evaluate feasibility of single-session bilateral triple pelvic osteotomy with 8-hole iliac bone plates in dogs with bilateral hip dysplasia.

Design—Retrospective study.

Animals—95 dogs with bilateral hip dysplasia.

Procedure—Medical records were reviewed, and information was obtained on signalment; body weight; angles of subluxation and reduction prior to surgery; durations of surgery and hospitalization; postoperative mobility; severity of lameness, radiographic grade of hip dysplasia, Norberg angle, and femoral head coverage before and after surgery; time required for radiographic evidence of iliac healing; change in pelvic diameter; implant integrity; and complications.

Results—Mean age at the time of surgery was 10.8 months, and mean weight was 35.2 kg (77.4 lb). Prior to surgery, mean angles of subluxation were 2.2° on the right and 2.6° on the left; mean angles of reduction were 25.9° on the right and 27.3° on the left. Mean surgical time was 95 minutes. All but 1 dog were able to walk on their own by the fourth day after surgery. Mean hospitalization time was 7.5 days. Clinical signs of lameness and radiographic grade of hip dysplasia were significantly improved during follow-up examinations. Mean time for radiographic iliac healing was 8 weeks. None of the plates and only 7 of the 1,520 (0.5%) screws loosened after surgery. Nineteen dogs had complications, but all complications were minor.

Conclusions and Clinical Relevance—Results suggest that single-session bilateral triple pelvic osteotomy with 8-hole iliac bone plates is effective for treatment of dogs with bilateral hip dysplasia. (*J Am Vet Med Assoc* 2003;222:54–59)

Triple pelvic osteotomy (TPO) is currently recommended for treatment of hip dysplasia in young dogs, because it is thought to slow the development of **degenerative joint disease (DJD)**.[1-14] Triple pelvic osteotomy is superior to conservative management and excision arthroplasty[7] and improves hip joint congruency, reducing articular cartilage stress and hip joint laxity.[4] Although preexisting DJD does not necessarily dictate a poor clinical outcome in dogs undergoing TPO,[1] and dogs with early DJD may still be suitable candidates for TPO,[3] the ideal candidates for TPO are immature dogs without irreversible degenerative changes of the hip joint.[2,4-6,8]

The current literature recommends that the surgical procedures be separated by 2 to 4 weeks in dogs undergoing bilateral TPO.[1-6,8-14] However, age is an important factor in the development of DJD in dogs with hip dysplasia, with dogs that are 12 months old at the time of surgery being approximately 7 times as likely to have DJD as dogs that are 6 months old.[1] Thus, staging may allow degenerative changes in the hip joint operated on second to progress because of the delay in surgery. In addition, shifts in weight bearing after the first procedure may place additional stress on the second hip joint, further exacerbating these degenerative processes. Beyond this, use of staged surgical procedures entails 2 anesthetic episodes, 2 surgical episodes, and 2 periods of convalescence. Thus, performing bilateral TPO during a single surgical session may be of benefit. The purpose of the study reported here was to evaluate the feasibility of single-session bilateral TPO with 8-hole iliac bone plates in dogs with bilateral hip dysplasia.

Criteria for Selection of Cases

Medical records of dogs referred to the All-Care Animal Referral Center between 1996 and 1999 in which 2 TPO plates were billed on the same invoice were identified with a computerized search. Dogs were eligible for inclusion in the study if history and results of physical examination were consistent with a diagnosis of hip dysplasia (ie, 1 or more of the following clinical signs were identified: reduced activity, signs of hip joint pain, hind limb lameness, Ortolani sign, Barden sign, and atrophy of the hind limb muscles) and the diagnosis had been confirmed by means of radiography of the pelvis. Only those dogs with radiographic evidence of bilateral hip dysplasia, defined as < 50% coverage of the femoral heads by the acetabula bilaterally on a standard ventrodorsal radiographic view of the pelvis, in which bilateral TPO had been performed during a single surgical session were eligible for inclusion in the study. Dogs with other clinically important concurrent diseases and dogs with markedly abnormal results for clinicopathologic testing prior to surgery were excluded.

From the All-Care Animal Referral Center, 18440 Amistad St, Fountain Valley, CA 92708 (Borostyankoi, Rooks, Kobluk, Reed); and Banfield, 5576 S Redwood Rd, Murray, UT 84123 (Littledike).

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Address correspondence to Dr. Borostyankoi.

Procedures

For dogs included in the study, data obtained from the medical records included age and weight at the time of surgery, breed, sex, and angles of subluxation and reduction prior to surgery.

Eligibility for TPO—Dogs were considered candidates for TPO only if they had radiographic evidence of hip dysplasia and had no more than minimal radiographic signs of DJD, defined as minimal or no abnormal bony changes involving the acetabula or femoral heads. In addition, dogs with an angle of reduction > 40° were not considered candidates for TPO.

Surgical procedure—Dogs were anesthetized with diazepam (0.22 mg/kg [0.1 mg/lb], IV) and propofol (0.11 mg/kg [0.05 mg/lb], IV); anesthesia was maintained with isoflurane. Cefazolin sodium (22 mg/kg [10 mg/lb], IV) was given prior to surgery. A purse-string suture was placed around the anus, and hair was clipped from all surfaces of the caudal third of the trunk, cranial fourth of the tail, and both hind limbs as far distally as the tarsi. The clipped area was then prepared for aseptic surgery, and the dog was suspended by both hind limbs several centimeters above the surgery table to allow for final preparation. Sterile bandage material was used to enclose the tail and both hind limbs from the tarsi distally. Multiple layers of sterile draping material were positioned to allow approaches to the ventral aspect of the pelvis and to both ilia without the need for redraping.

A standard approach to the ventral aspect of the pubis was performed, and the pelvic symphysis was exposed. The ventral pubic muscles were undermined and reflected as needed to expose the pubic bones, and a triangular portion of the pubic bones was removed with an oscillating bone saw (**Fig 1**) to prevent impingement following rotation of the iliac shafts. The limits of this triangular portion of bone consisted of 2 points at the most cranial edges of the pubic bones, each 5 mm to either side of the midline, and a point on the pelvic symphysis 5 mm cranial to a line connecting the caudal borders of the obturator foramina. The remainder of the pelvic symphysis was osteotomized with the same saw. Pelvic muscles and subcutaneous tissues were closed with simple interrupted sutures of polydioxanone, and skin was closed with staples.

The dog was then positioned in left or right lateral recumbency, and a standard approach to the iliac body was performed. The iliac shaft was osteotomized, as described,[15] with an oscillating bone saw at an angle of approximately 10 to 15° to a line perpendicular to the long axis of the shaft, just caudal to the sacroiliac joint. The caudal portion of the iliac shaft was then rotated to increase coverage of the femoral head, and the osteotomy was stabilized with an 8-hole iliac bone plate[a] (**Fig 2**) and cancellous bone screws.[b] The adjustable iliac bone plate is available in 2 angles providing 25° and 35° of rotation with left- and right-sided configurations. The authors used the 25° plate for hip joints with an angle of reduction < 25° and the 35° plate for hip joints with an angle of reduction between 35° and 40°. The 25° plate was twisted with custom plate benders for hip joints with angles of reduction between 25° and 35° to achieve the desired angle of iliac rotation. The plates were bent if necessary to optimize plate-to-bone contact without affecting the rotation angle. Muscles and subcutaneous tissues were closed with simple interrupted sutures of polydioxanone; skin was closed with staples. The dog was then positioned to allow exposure of the contralateral ilium, and iliac osteotomy and stabilization were repeated.

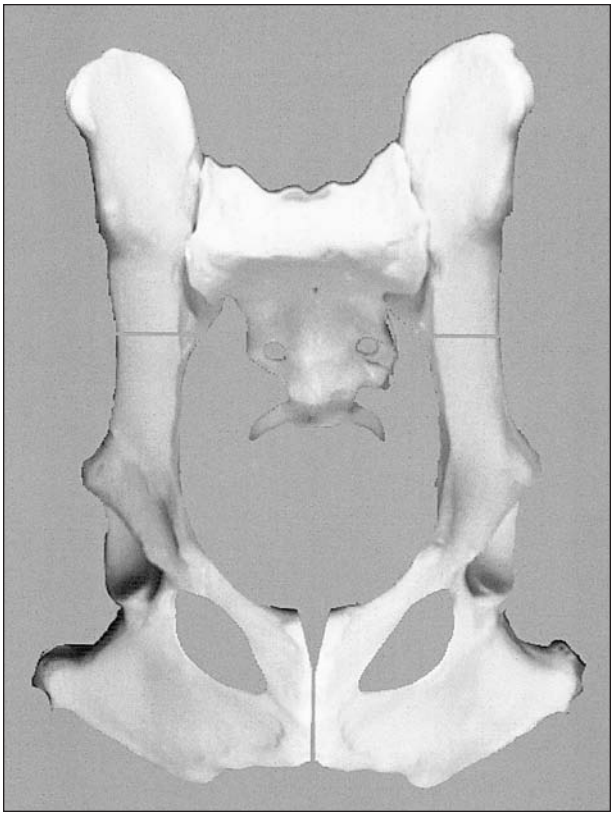

Figure 1—Location of the 3 osteotomies (1 pubic and 2 iliac) performed in dogs undergoing single-session bilateral triple pelvic osteotomy for treatment of bilateral hip dysplasia. Notice the triangular-shaped fragment removed from the cranial aspects of the pubic bones to prevent impingement following rotation of the iliac shafts.

Immediately after surgery, while the dog was still anesthetized, standard ventrodorsal and lateral radiographic views of the pelvis were obtained (**Fig 3**). The anal purse-string suture was removed, and the dog was allowed to recover from anesthesia. During the immediate postoperative period, analgesic drugs were administered as needed; in general, dogs received nonsteroidal anti-inflammatory drugs PO.

Postoperative monitoring—After surgery, dogs were monitored to assess their ability to stand and walk without assistance and to determine whether they were able to urinate and defecate. Complications that were identified were recorded.

At the time of discharge, owners were instructed to confine their dogs and restrict activity to short leash walks outdoors for urination and defecation. Owners were asked to return their dogs 1, 2, 4, 8, and 12 weeks after surgery for follow-up examinations and radiography. Additional examinations were performed as necessary until iliac healing was radiographically complete

Figure 2—Photographs of 8-hole iliac plates used for single-session bilateral triple pelvic osteotomy in dogs. The adjustable iliac bone plate has 8 neutral screw holes and is available in 2 angles (25° and 35°) with left- and right-sided configurations.

(defined as bridging of the iliac osteotomy sites by bony callus and reduction of the radiolucent appearance of the osteotomy sites) or judged to have progressed sufficiently to allow the dogs to return to usual activity and exercise levels. For the present study, owners were contacted by the authors and asked to return their dogs for long-term follow-up evaluation and radiography.

Owners of all sexually intact dogs were advised to have their dogs spayed or neutered or to avoid using their dogs for breeding.

Clinical assessment—For purposes of the present study, medical records were reviewed, and a clinical grade was assigned to each dog prior to surgery, immediately after surgery, and during each recheck examination. Grades ranged from 1 to 4 with 1 (poor) indicating constant lameness, signs of pain during examination of the range of motion, moderate to severe muscle atrophy, and restricted exercise; 2 (fair) indicating mild lameness, signs of mild pain during examination

Figure 3—Ventrodorsal radiographic projection of the pelvis of a dog with hip dysplasia following single-session bilateral triple pelvic osteotomy with 8-hole iliac plates.

of the range of motion, mild muscle atrophy, and reduced exercise; 3 (good) indicating intermittent lameness, intermittent signs of pain during examination of range of motion, no muscle atrophy, and unrestricted exercise; and 4 (excellent) indicating clinically normal.

Radiographic assessment—All radiographs from each dog were reviewed by a single board-certified radiologist who assigned a grade for severity of hip dysplasia prior to surgery, immediately after surgery, and during each recheck examination. Grades ranged from 1 to 4 with 1 (excellent) defined as superior conformation with tight joint spaces and nearly complete coverage of the femoral heads by the acetabula, 2 (good) defined as congruent joint spaces with most of the femoral heads covered by the acetabula, 3 (fair) defined as slight incongruency of the joint spaces with shallow-appearing acetabula, and 4 (borderline) defined as incongruency of the joint spaces with shallow-appearing acetabula and bony projections. In addition, pelvic diameter, defined as the distance between the tuber ischii, was measured on radiographs obtained before and after surgery, and Norberg angles and percentages of femoral head coverage by the acetabula[1] were measured on radiographs obtained before and after surgery and during each recheck examination. Radiographs were also examined for any evidence of implant loosening or breakage.

Data analysis—Paired-sample *t*-tests were used to compare values for pelvic diameter, percentage femoral head coverage, and Norberg angle obtained before surgery with values obtained after surgery and during recheck examinations. Sign tests were used to compare clinical and radiographic grades before surgery with grades after surgery and during recheck examinations. All analyses were performed with standard software.[c] Values of $P < 0.05$ were considered significant.

Results

Ninety-five dogs met the criteria for inclusion in the study, including 53 males (34 sexually intact and 19 castrated) and 42 females (23 sexually intact and 19 spayed). Mean ± SD age at the time of surgery was 10.8 ± 5.4 months (range, 5 to 24 months). Mean weight was 35.2 ± 8.5 kg (77.4 ± 18.7 lb; range, 15.9 to 61.8 kg [35 to 136 lb]). Twenty-one dogs were Labrador Retrievers, 12 were Rottweilers, 15 were Golden Retrievers, 6 were German Shepherd Dogs, and 5 were Saint Bernards. The remaining 36 dogs represented a variety of breeds or were of mixed breeding. Mean angle of subluxation prior to surgery was 2.2° for the right hip joints (range, 0 to 15°) and 2.6° for the left hip joints (range, 0 to 15°). Mean angle of reduction prior to surgery was 25.9° for the right hip joints (range, 15 to 40°) and 27.3° for the left hip joints (range, 15 to 40°).

Mean duration of surgery was 95 minutes (range, 60 to 165 minutes). Forty-one dogs were able to stand unassisted within 24 hours after surgery, and an additional 33 were able to stand unassisted within 48 hours after surgery. All dogs were able to stand and walk without assistance by the fourth day after surgery, except for 1 dog with transient neuropraxia that did not walk without assistance until 10 days after surgery. Mean time from surgery to discharge was 7.5 days (range, 5 to 16 days).

Clinical grade—Information in the medical records was sufficiently detailed for assignment of a clinical grade in 30 of the 95 dogs for the beginning of the study. For these dogs, median clinical grade prior to surgery was 2 (range, 1 to 4). For 15 of these 30 dogs, information recorded in the medical record was sufficient to assign a clinical grade 1 year after surgery. For these 15 dogs, median clinical grade 1 year after surgery (3; range, 2 to 4) was significantly ($P < 0.01$) higher than median grade prior to surgery. Similarly, for 10 of the 30 dogs, information in the medical record was sufficient to assign a clinical grade 2 years after surgery, and for 13 of the 30 dogs, information was sufficient to assign a clinical grade ≥ 3 years after surgery. Median grades 2 (4; range, 3 to 4) and ≥ 3 (4; range, 2 to 4) years after surgery were significantly ($P < 0.01$) higher than median grade prior to surgery. Most patients were assigned clinical grades of good or excellent during follow-up examinations, and follow-up grades were significantly improved, compared with the preoperative grades ($P < 0.01$).

Radiographic evaluation—Radiographs of all 95 dogs obtained prior to and immediately after surgery were available for review. Five dogs were lost to follow-up immediately after discharge from the hospital, and an additional 20 dogs were lost to follow-up 4 weeks after surgery. Of the remaining 70 dogs, 24 (34%) had radiographic evidence of bony union of the osteotomy sites by 6 weeks after surgery, and all 70 had radiographic evidence of bony union by 8 weeks after surgery. Pelvic diameter immediately after surgery (mean ± SD, 14.0 ± 1.5 cm) was significantly ($P < 0.01$) greater than pelvic diameter before surgery (12.9 ± 1.5 cm). None of the dogs were reported to have constipation, tenesmus, or dysuria. None of the female dogs were reported to have given birth, either by natural means or cesarean section, after surgery.

Radiographic grades prior to and immediately after surgery were assigned to 33 of the 95 dogs with long-term radiographic follow-up. Median grades were 2 (range, 1 to 3) for the right and left hip joints prior to surgery, and 1 (range, 1 to 3) immediately after surgery. Median grades after surgery were significantly ($P < 0.01$) lower than median grades prior to surgery. Radiographic grades were assigned 1 year after surgery in 13 of the 95 dogs; median grade was 1 (range, 1 to 3) for the right hip joints and 1 (range, 1 to 2) for the left hip joints; median grades 1 year after surgery were significantly ($P < 0.01$) lower than median grades before surgery. Radiographic grades were assigned 2 years after surgery in 8 dogs; median grades were 1 (range, 1 to 4) for both the right and left hip joints. Radiographic grades were assigned ≥ 3 years after surgery in 17 dogs; median grades were 1 (range, 1 to 4) for both the right and left hip joints. Radiographic grades assigned 2 years after surgery and ≥ 3 years after surgery were not significantly different from grades assigned prior to surgery.

Mean ± SD Norberg angles prior to surgery were 93.3 ± 12.9° for the right hip joints and 96.1 ± 11.4° for the left hip joints (n = 34). Norberg angles were 117.0 ± 8.9° for the right hip joints and 122.9 ± 8.0° for the left hip joints immediately after surgery (n = 34), 115.7 ± 11.3° for the right hip joints and 122.7 ± 6.8° for the left hip joints 1 year after surgery (16), 121.7 ± 8.8° for the right hip joints and 127.8 ± 9.3° for the left hip joints 2 years after surgery (12), and 115.3 ± 13.1° for the right hip joints and 127.7 ± 12.8° for the left hip joints ≥ 3 years after surgery (17). Values obtained immediately after surgery and 1, 2, and ≥ 3 years after surgery were significantly ($P < 0.01$) greater than values obtained prior to surgery.

Prior to surgery, mean ± SD femoral head coverage was 42.8 ± 18.1% for the right hip joints and 38.2 ± 15.2% for the left hip joints (n = 34). Femoral head coverage was 78.1 ± 9.6% for the right hip joints and 80.1 ± 11.3% for the left hip joints immediately after surgery (n = 33), 77.5 ± 19.7% for the right hip joints and 79.6 ± 12.9% for the left hip joints 1 year after surgery (16), 83.1 ± 10.5% for the right hip joints and 84.6 ± 9.8% for the left hip joints 2 years after surgery (12), and 79.3 ± 14.0% for the right hip joints and 81.8 ± 15.0% for the left hip joints ≥ 3 years after surgery (18). Values obtained immediately after surgery and 1, 2, and ≥ 3 years after surgery were significantly ($P < 0.01$) greater than values obtained prior to surgery.

Seven of the 1,520 screws had radiographic evi-

dence of loosening during 1 or more follow-up examinations; however, none of these screws had to be removed or replaced.

Complications—Four (4%) dogs had transient diarrhea after surgery, 4 (4%) had incisional drainage, 4 (4%) removed the skin staples, 3 (3%) had transient bloody feces, and 1 (1%) each had hematuria, scrotal swelling, seroma formation, and transient bilateral neuropraxia.

Discussion

Results of the present study support the use of single-session bilateral TPO with 8-hole iliac bone plates for the treatment of dogs with bilateral hip dysplasia. There was no evidence of implant failure, and complications that did occur were generally minor. In addition, the fixation was sufficiently stable to allow normal healing of the osteotomy sites.

Dogs in the present study were in the expected age group with appropriate sex and breed distributions. Only dogs with clinical evidence of hip dysplasia and radiographic evidence of joint laxity with, at most, minimal DJD were considered candidates for this surgery. The angle of reduction was used as part of the clinical evaluation to select appropriate candidates for TPO surgery, based on clinical experience of the authors and reports in the literature.[5] Dogs with an angle of reduction > 40° were considered ineligible for the surgery on the basis of the authors' experience and results of a previous study.[16]

In the present study, clinical grades following bilateral TPO were significantly improved, compared with grades prior to surgery. Unfortunately, numbers of dogs for which grades could be assigned were small, making it difficult to draw any conclusions from these results. However, our results are consistent with results of other studies[1,3] in which TPO resulted in a significant improvement in clinical signs in dogs with hip dysplasia. Radiographic grades for dogs in the present study were significantly improved, compared with preoperative grades, immediately after and 1 year after surgery, but were not significantly different from preoperative scores 2 and ≥ 3 years after surgery. Again, the small number of dogs makes it difficult to draw any conclusions. However, these results are consistent with results of previous studies[1,3] in which TPO did not prevent the progression of radiographic signs of DJD.

The significant improvements in Norberg angle and femoral head coverage in the present study suggest that bilateral TPO substantially improved the biomechanical conformation of the hip joints. Improvements in both of these measurements were detected throughout the follow-up period, suggesting that these changes were maintained.

Staging of the procedures, with a delay of 2 to 4 weeks between surgeries, has been recommended for dogs undergoing bilateral TPO.[13] However, a previous study[17] found increased loading of the untreated hip joint 5 weeks after treatment of the contralateral joint in dogs undergoing unilateral TPO. This increased loading was attributed to a compensatory shift away from the treated limb, suggesting that the untreated hip joint will be exposed to increased loading while the first treated joint heals in dogs undergoing staged bilateral TPO. Thus, single-session bilateral TPO may have an advantage over staged bilateral TPO in that both joints are treated at the same time. In addition, single-session bilateral TPO requires only 3 osteotomies (2 iliac and 1 pubic), whereas staged bilateral TPO requires 6 osteotomies (2 iliac, 2 pubic, and 2 ischial).

In the authors' opinion, the 8-hole iliac plate used in the present study may have some advantages over other plates used for TPO in dogs. We found that these plates could easily be adjusted to a desired conformation with simple hand-held plate benders at the time of surgery. In addition, the plate accommodates 8 screws, compared with the 6 screws used by other plates.[d] We also found that the conformation of the 8-hole iliac plate was such that following fixation of the iliac osteotomy, the craniodorsal portion of the caudal iliac component did not project as far laterally into the gluteal musculature as may occur with other TPO plates, so that this spike of bone did not have to be removed, as has been recommended.[13]

Screw loosening and pelvic narrowing are the most commonly reported complications of TPO in dogs.[6,11,18-20] Screw migration has been reported to occur in 33 to 36% of dogs undergoing TPO,[20] and a recent study[20] investigating risk factors for screw migration reported an incidence of 22%, with 62.5% of osteotomies having at least 1 migrating screw. By contrast, only 7 screws had radiographic evidence of loosening in the present study, and none of these screws had to be removed or replaced. In addition, none of the plates had radiographic evidence of breakage.

Rotation of the ilia in the present study resulted in the spreading of the caudal components of the pelvis, as evidenced by the significant postoperative increase in the distance between the tuber ischii. In addition, none of these dogs were reported to have tenesmus, constipation, or dysuria after surgery.

Bridging callus and ossification of the osteotomy lines were used as radiographic evidence of healing in the present study. All 70 dogs in the present study that could be evaluated had radiographic evidence of osteotomy site healing by 8 weeks after surgery.

Forty-one of the 95 dogs in the present study were able to stand unassisted within 24 hours after undergoing bilateral TPO, and all but 1 were able to stand and walk unassisted within 4 days after surgery. Mean duration of hospitalization after surgery was 7.5 days.

Complications that developed in the present study were generally minor. The diarrhea, hematuria, incisional drainage, seroma formation, scrotal swelling, and bloody feces that developed were mild and transient and did not adversely affect the overall outcome. Premature removal of the skin staples did not cause any clinical problems. The transient neuropraxia was likely a result of excessive soft tissue trauma during surgery.

[a]Adjustable iliac bone plate, All-Care Animal Referral Center, Fountain Valley, Calif.
[b]Cancellous orthopedic screws, Synthes Inc, Paoli, Pa.
[c]SPSS 10 for Macintosh, SPSS Inc, Chicago, Ill.
[d]Canine pelvic osteotomy plate, Slocum Enterprises, Eugene, Ore.

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