J Vet Clin 22(4) : 328-335(2005)

Application of a Modified Triple Pelvic Osteotomy for Treatment of Hip Dysplasia in Dogs

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Abstracts: The objective of this study was to evaluate the effects of modified triple pelvic osteotomy (TPO). The procedures of modified TPO were composed of two iliac osteotomies and a pubic symphysiotomy at a time. Medical records of modified TPO treatment on 36 dogs and of unilateral TPO on 7 dogs were reviewed on the basis of signalment, body weight, operation time, healing time of osteotomy sites and complications from October 2002 to September 2004. The values of clinical status and hip dysplasia, Norberg angle, percentage of femoral head coverage and pelvic diameter from radiographs taken preoperative, immediately postoperative, 2, 4, 8, 12 and 24 weeks after operation, respectively, were measured. In unilateral TPO, the dogs could start standing without assistance from 3.0±1.0 days and walking from 8.3±0.6 days (n=3). Mean clinical grade before and 24 weeks after surgery were 2.2±0.42 (n=6) and 3.5±0.7 (n=2), respectively. Mean operation time was 107.3±38.9 minutes (n=4). In modified TPO, the dogs were seen to start standing without assistance from 4.9±3.7 days and walking from 7.3±4.8 days (n=25). Mean clinical grade before surgery and 24 weeks after surgery were 2.3±1.5 (n=27) and 3.2±0.7 (n=9), respectively. Postoperative clinical grade significantly improved against preoperative clinical grade ($P<0.01$). Mean operation time was 143±42.8 minutes (n=24). This was shorter than time for twice unilateral TPO. By comparison with preoperative values, postoperative mean radiographic grade, percentage of femoral head coverage and Norberg angle measured at the recheck time point significantly increased ($P<0.01$). Mean postoperative pelvic diameter was significantly larger than preoperative pelvic diameter in modified TPO ($P<0.01$) but not in unilateral TPO. These results indicated that modified TPO was effective technique for the treatment of hip dysplasia in dogs.

Key words : hip dysplasia, dog, modified triple pelvic osteotomy.

Introduction

Canine hip dysplasia (CHD) is one of the most common orthopedic diseases of large breed dogs, which results from abnormal development of the hip joint in the young dog. It induces clinical signs of pain, lameness, reluctance to walk, decreased muscle mass, "bunny hopping" gait[3]. CHD may be unilateral or bilateral and 70 to 97% bilateral affection has been reported[4].

Triple pelvic osteotomy (TPO) has been reported to treat canine hip dysplasia by improving femoral head coverage and joint congruity and by reducing stressful force on the hip joint and the possibility of progression of the degenerative joint disease (DJD), eliminating clinical signs postoperatively[2,4]. An ideal candidate for TPO is an immature (between 5 and 9 months of age) dog with little or preferably no DJD signs[5,7]. The demerits of unilateral TPO are marked progression of radiographic DJD signs with age and increased weight bearing stress on later operated hip joint along with 2 anesthetic episodes, 2 operations, 2 convalescences[2,12]. The complications associated with TPO include femoral neck impingement, reduced abduction by over-rotated acetabulum, decrease in size of pelvic canal inducing constipation and dysuria, implants failure, non-union of osteotomy sites and persistent joint incongruity[13]. Additionally, there are also tenesmus, diarrhea, hematuria, incisional drainage, seroma formation, scrotal swelling and hematochezia[16]. On this account, modified TPO composed of osteotomy and fixation of both ilium and pubic symphysiotomy at one operation was performed to alleviate weak points of unilateral TPO.

This study was aimed at evaluating a modified TPO which was performed bilaterally at a time to treat hip dysplastic dogs. We compared modified TPO with unilateral TPO with respect to clinical status, pelvic diameter, times required for operation and bone healing, procedures and complications.

Materials and Methods

Animals

Medical records including signalment (age, body weight, breed, sex) of 36 dogs treated by modified TPO were reviewed. The dogs included 15 males and 21 females (1 neutered female). The breeds were Labrador Retrievers (11 dogs), Golden Retrievers (9 dogs) and Bernese Mountain dog (8 dogs). The remaining 8 dogs were Flat-coated Retriever, Basset hound, Rottweiler, Bulldog, Great Pyrenees, Samoyeds and Newfoundland. Additionally, data on 7 dogs with unilateral TPO were included in this study to compare with modified TPO. The breeds were Labrador Retrievers (2 dogs),

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Golden Retrievers(2 dogs), Rottweiler(1 dog), Newfoundland (1 dog), Sapsal(1 dog). In modified TPO, mean (±SD) age and body weight of the animals at the time of surgery were 8.7±3.0 months and 26.9±7.6 kg (n=36) respectively. In unilateral TPO, mean (±SD) age and body weight of the animals were 9.0±4.9 months and 24.8±7.5 kg, respectively.

Surgical Procedures

Anesthesia. The dogs were premedicated with atropine (0.04 mg/kg, subcutaneously) and subsequently sedated with acepromazine (0.1 mg/kg, intravenously) and morphine (0.5 mg/kg, subcutaneously). The anesthetic induction agent was ketamine (5 mg/kg, intravenously) and the anesthesia was maintained with isoflurane. Cefazolin sodium (25 mg/kg, intravenously) was administered before surgery for the prophylaxis. The hair was clipped from caudal trunk to tarsal joint, included in a half of tail and the skin was prepared with chlorhexidine shampoo and alcohol in turns 4 times for aseptic surgery.

Surgical Techniques. At first, the dogs were positioned in dorsal recumbency for pubic symphysiotomy. The skin was incised alongside the penis for exposure of pubis[6]. Subcutaneous tissues including deep fascia and fat were separated with electrocauterization until whole pubic symphysis was recognized. Two Hohmann retractors were applied on the cranial and caudal end of symphysis respectively for safe and easy approach to the pubic symphysis and then an obliquely sharpened osteotome was used to elevate subpelvic tendon, adductor m. and gracilis m. from pubic symphysis for complete exposure.

Cranial half of pubic symphysis was ostetomized to remove triangle-shaped fragment which prevented impingement during rotation of osteotomized ilium (Fig 1).

Caudal half of symphysis was also trimmed to have the surface flat. And then pubis was split longitudinally on the symphysis by osteotome and lamina spreader, having a care to avoid soft tissue injuries including the urethra. The pubis was stabilized with a loose cerclage wire passed between obturator foramina. The muscles, fasciae and subcutaneous tissue adjacent to pubic symphysis and skin were sutured by continuous or interrupted patterns.

After pubic symphysiotomy, the dogs were positioned in lateral recumbency, and iliac body was approached from the lateral side[16]. Saline was injected with 10ml syringe into the subcutaneous spaces and fasciae to facilitate exposure of ilium.

Three Hohmann retractors were positioned at the dorsal margin of ilium so that iliac shaft could be exposed enough to do osteotomy with an oscillating bone saw. The first Hohmann retractor was placed in the dorsal border of iliac shaft just caudal to sacroiliac joint to retract gluteal muscles dorsally.

A hole was drilled more cranial to the first Hohmann retractor about sacral vertebral body, which made an anchorage of the second Hohmann retractor preventing a slippage during retraction of muscles. The third Hohmann retractor was fixed caudal to the first one. With bone elevators, ventral borders of ilium were separated to expose caudoventral body of sacrum and the osteotomy-guiding elevator was slid down the medial surface of iliac shaft dorsally with gentle elevation of soft tissues, which was ventral landmark of iliac osteotomy. Ilium was osteotomized with an oscillating bone saw in a line perpendicular to ventral borders where plate would be fixed (Fig 2).

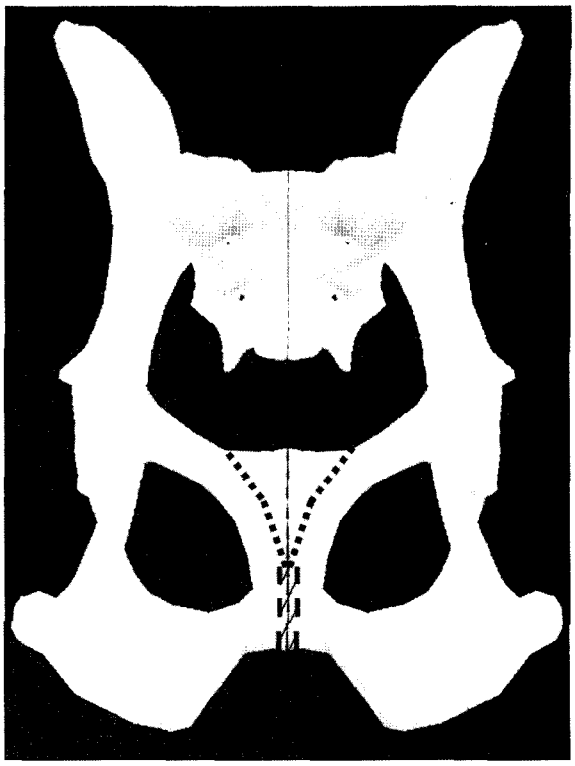

Fig 1. Schematic drawing of pubic osteotomy line. Note that the cranial half part shown as dotted line is parallel to the medial border of obturator foramen. Caudal half part (dashed line) need to be osteotomized evenly (1/3 to 1/2 of the width of pubic symphysis.)

After iliac osteotomy, 30-40 degrees pelvic osteotomy plate (Canine pelvic osteotomy plate, Slocum Enterprises, Eugene, Oregon) was fixed to the caudal fragment of ilium with 4.0 mm cancellous bone screws. After rotating the caudal fragment, cranial fragment of ilium was secured with the plate by same way as stated above. The surgery site was closed routinely by layers with absorbable suture and staples. The contralateral iliac osteotomy was performed repeatedly with same procedures.

Postoperatively, ventrodorsal and lateral radiographs of pelvis were taken under anesthesia and a fentanyl patch (7.5 mg) was attached to lateral flank to alleviate pain.

Postoperative Management

For the first week postoperatively, the dogs were under the

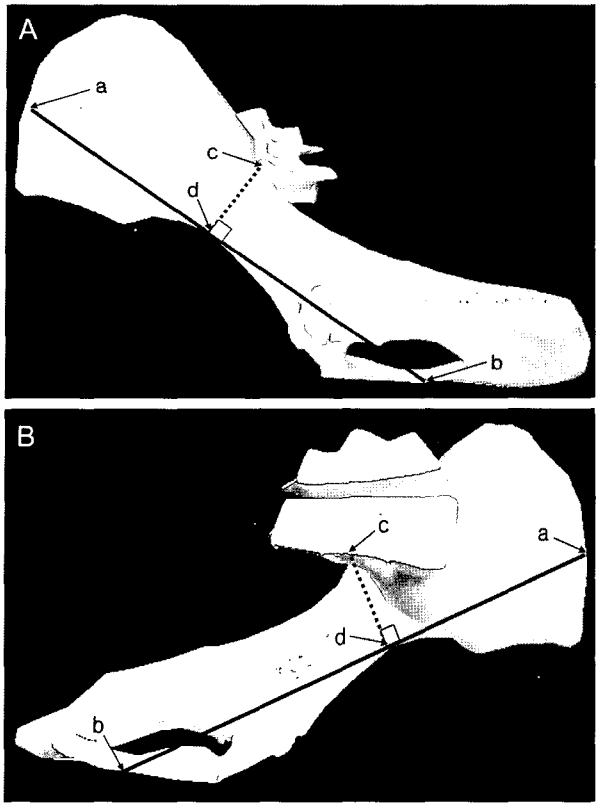

Fig 2. Representation of iliac osteotomy sites. A. lateral view, B. medial view. Line ab (solid) is a tangent line drawn contacting the ventral border of ilium at the point where osteotomy guiding elevator is slid down the medial surface of iliac shaft dorsally just caudal to the caudoventral body of sacrum (line cd: dotted). Line ab is perpendicular to line cd.

cage confinement. Activity was restricted to leash walking for the second week with a gradual increase to normal activity 1 to 2 months following surgery. Cephalexin (22 mg/kg, PO) was administered for 2 weeks postoperatively.

Evaluation

Clinical Examination. To score clinical status of the experimental dogs, the following grading system (Table 1) was used[2].

Radiographic Evaluation. The grade of hip dysplasia, Norberg angle, percentage of femoral head coverage and pelvic diameter were measured from preoperative, immediately postoperative, 2, 4, 8, 12 and 24 weeks postoperative radiographs (hip extended - ventrodorsal pelvic view) taken by Orthopedic Foundation for Animals (OFA).

The Norberg angle was resultant angle composed of two lines; one was from cranial acetabular margin to the center of femoral head, the other was from the center of femoral head to the center of the opposite femoral head[9,10,14]. The percentage of femoral head coverage (%) was derived from the following formula[15]:

$$\text{Percentage of femoral head coverage (\%)} = \frac{\text{Distance between A and B}}{\text{Distance between A and C}}$$

A: fovea capitus B: dorsal acetabular rim C: physeal scar

Pelvic diameter was the distance between two ischial tuberosities[2]. The severity of hip dysplasia was graded into 4 classes as in Table 2[2]. The time for radiographic evidence of iliac bone union and implant integrity (including broken screws and plates, loosening of screws) were checked at the follow-up periods.

Results

In modified TPO the dogs were seen to start standing with-

Table 1. Criteria for assigning clinical grade in dogs[2]

Evaluation	Grade	Condition
Poor	1	Constant lameness, signs of pain during examination of the range of motion, moderate to severe muscle atrophy and restricted exercise
Fair	2	Mild lameness, signs of mild pain during examination of the range of motion, mild muscle atrophy and reduced exercise.
Good	3	Intermittent lameness, intermittent signs of pain during examination of range of motion, no muscle atrophy and unrestricted exercise.
Excellent	4	Clinically normal

Table 2. Criteria for grading the severity of hip dysplasia in dogs based on preoperative and postoperative radiographs[2]

Evaluation	Grade	Condition
Excellent	1	Superior conformation with tight joint spaces and nearly complete coverage of the femoral heads by the acetabula
Good	2	Congruent joint spaces with most of the femoral heads covered by the acetabula.
Fair	3	Slight incongruency of the joint spaces with shallow-appearing acetabula.
Borderline	4	Incongruency of the joint spaces with shallow appearing acetabula and bony projections.

out assistance from 4.9±3.7 days and able to walk from 7.3±4.8 days (n=25) (Table 3). Average operation time spent for surgical correction was 143±42.8 minutes (n=24).

In unilateral TPO the dogs started standing without assistance from 3.0±1.0 days and walking from 8.3±0.6 days. Duration of surgery was 107.3±38.9 minutes.

Clinical Assessment

In modified TPO, preoperative mean clinical grade was 2.3 ±1.5 (n=27). Mean clinical grade 24 weeks after surgery was 3.2±0.7 (n=9) and this was significantly ($P<0.01$) higher than preoperative clinical grade (Table 3). In unilateral TPO, preoperative mean clinical grade was 2.2±0.42 (n=6) and that of 24 weeks after surgery was 3.5±0.7 (n=2).

Radiographic Evaluation

In modified TPO, mean radiographic hip grade of both hip joints before surgery was 3.2±0.9 (Table 4). The grades of right and left hip joint immediately after surgery were 2.7±0.9 and 2.7 ±1.1 respectively (n=36). Radiographic hip grades assigned 2, 4, 8, 12, 24 weeks after surgery were significantly lower than preoperative hip grades ($P<0.01$).

In unilateral TPO, preoperative mean hip grades of right and left hip joint were 3.5±0.7 and 3.4±0.5 respectively (Table 5). The grades of right and left hip joints immediately after surgery were 1.5±0.7 and 2.8±0.8 respectively. Postoperative mean grade was significantly ($P<0.01$) lower than preoperative values.

In the follow-up radiographs with modified TPO, Norberg angle, joint congruency and portion of acetabulum covering femoral head were increased. Neither significant DJD signs nor pelvic diameter narrowing were observed (Fig 3,4). Mean values for percentage of femoral head coverage, Norberg angle measured at the recheck time points significantly increased ($P<0.01$). In unilateral TPO, mean values for percentage of femoral head coverge, Norberg angle obtained at follow-up periods significantly increased ($P<0.01$) compared with preoperative values.

In modified TPO, mean postoperative pelvic diameter (12.3±1.3 cm, n=36) was significantly ($P<0.01$) larger than preoperative pelvic diameter(11.5±1.5 cm, n=36). In contrast, postoperative pelvic diameters in unilateral TPO were

Table 3. Mean clinical grade, age, body weight, time for standing and walking without assistance, duration of surgery and complication in modified and unilateral TPO

		Modified	Unilateral
Clinical grade	preoperative	2.3±1.5[a] (n=27)	2.2±0.42 (n=6)
	24weeks later	3.2±0.7[b] (n=9)	3.5±0.7 (n=2)
Age (months)		8.7±3.0 (n=36)	9.0±4.9 (n=7)
Body weight (kg)		26.9±7.6 (n=36)	24.8±7.5 (n=7)
Standing without assistance (days)		4.9±3.7 (n=25)	3.0±1.0 (n=3)
Walking without assistance (days)		7.3±4.8 (n=25)	8.3±0.6 (n=3)
Duration of surgery (minutes)		143±42.8 (n=24)	107.3±38.9 (n=4)
Complications		7/36*	2/7**

*neurapraxia 1 dog, seroma formation 1 dog, loosening of screw 4 dogs, broken screw 1 dog
** seroma formation 1 dog, broken screw 1 dog
a, b; significant between two groups ($p<0.05$)
n=number of dogs
Data were expressed as mean±SD

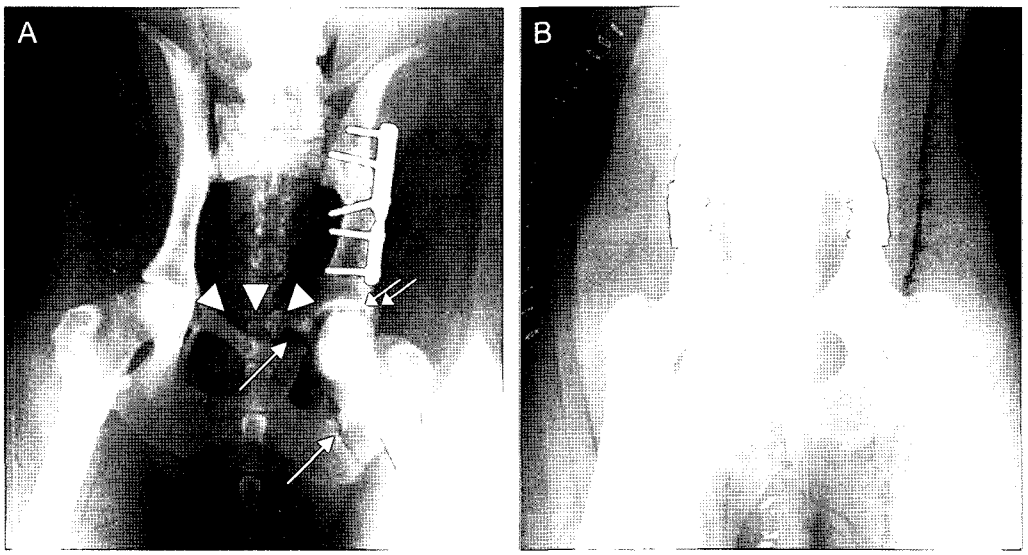

Fig 3. Postoperative radiographs of unilateral TPO (A) and modified TPO (B). Note that non-union of pubic and ischial osteotomy sites (single arrow), deformation of pelvic canal (arrow heads), over-coverage of hip joint (double arrows) in unilateral TPO.

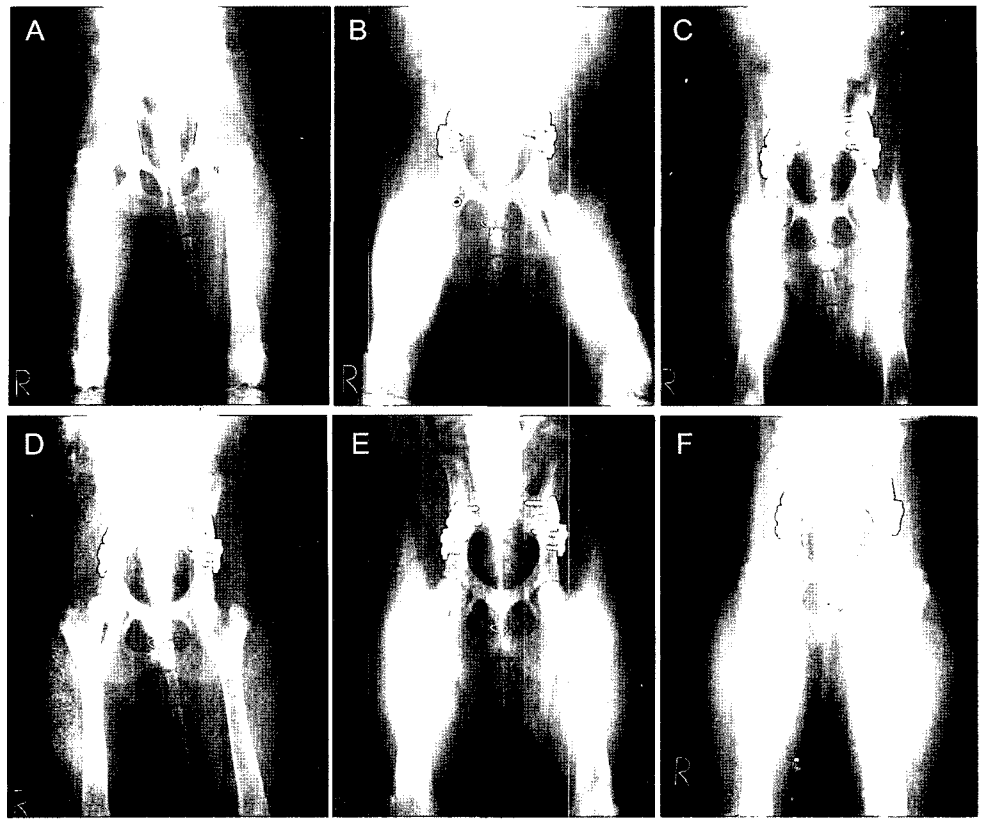

Fig 4. Pre- and postoperative radiographic views of modified TPO in a dog. A, B, C, D, E and F indicate the preoperative, immediately postoperative, 4, 8, 12 and 24 weeks after surgery, respectively. Notice the improvement of radiographic hip grade 24 weeks after surgery. Hip grades changed from 3 to1 (left hip joint) and from 2 to 1 (right hip joint) and there was no incongruency of coxofemoral joint space and covering rate of acetabulum over the femoral head increased. The pelvic canal shape was maintained well without definite malformation (pelvic narrowing).

Table 4. Pre- and postoperative radiographic assessment of dogs treated with modified TPO

Exam Date	Norberg angle (°)		Percentage of femoral head coverage (%)		Hip grade		Pelvic diameter (cm)
	R[a]	L[b]	R	L	R	L	
*Pre-op	86.5± 14.8 (n=36)	86.1± 18.7 n=36)	34.3± 28.9 (n=36)	35.0± 0.7 (n=36)	3.2± 0.9 (n=36)	3.2± 0.9 (n=36)	11.5± 1.5 (n=36)
**Post-op 0 days	101.0± 6.9 (n=35)	99.4± 19.9 (n=35)	55.5± 28.9 (n=35)	57.4± 34.3 (n=35)	2.7± 0.9 (n=35)	2.7± 1.1 (n=35)	12.3± 1.7 (n=36)
2 weeks	102.4± 14 (n=29)	105.2± 17 (n=29)	57.1± 31.0 (n=29)	63.7± 31.9 (n=29)	2.6± 1.0 (n=28)	2.4± 1.0 (n=28)	11.9± 2.1 (n=36)
4 weeks	104.4± 18 (n=30)	105.2± 20 (n=30)	63.5± 33.3 (n=30)	68.2± 35.3 (n=30)	2.4± 1.0 (n=30)	2.6± 1.0 (n=30)	12.6± 1.6 (n=36)
8 weeks	107.3± 13 (n=21)	107.5± 15 (n=22)	68.1± 25.7 (n=21)	73.5± 31.0 (n=22)	2.3± 0.8 (n=21)	2.4± 1.1 (n=22)	12.8± 1.4 (n=32)
12 weeks	109.1± 13 (n=17)	103.9± 17 (n=18)	69.6± 27.3 (n=17)	65.8± 32.8 (n=18)	2.4± 0.8 (n=16)	2.7± 1.1 (n=17)	12.9± 0.9 (n=30)
24 weeks	112.8± 12 (n=14)	105.8± 17 (n=15)	77.6± 24.0 (n=14)	64.4± 31.8 (n=15)	2.3± 0.8 (n=14)	2.7± 1.1 (n=16)	13.4± 1.1 (n=26)

[a]Right hip joint, [b]Left hip joint
*$p<0.01$ as compared with **.
n=the number of dogs. After discharge from hospital, follow-up data of some dogs were not obtained owing to owner's disagree to bring dogs for examination.
Data were expressed as mean±SD.

Table 5. Pre- and postoperative radiographic assessment of dogs treated with unilateral TPO

Exam Date	Norberg angle (°)		Percentage of femoral head coverage (%)		Hip grade		Pelvic diameter (cm)
	R[a]	L[b]	R	L	R	L	
Pre-op	82.0± 25.5* (n=2)	82.0± 9.9* (n=5)	25.0± 9.9* (n=2)	19.8± 15.2* (n=5)	3.5± 0.7* (n=2)	3.4± 0.5* (n=5)	10±1.4 (n=7)
Post-op 0 days	117.5±3.5** (n=2)	100.0±19.4** (n=5)	91.7± 11.8** (n=2)	68.1±36.2** (n=5)	1.5±0.7** (n=2)	2.8±0.8** (n=5)	10±1.5 (n=7)
2 weeks	124± 8.5** (n=2)	105.8±14.4** (n=5)	89.1±15.4** (n=2)	60.2±33.1** (n=5)	1.5±0.7** (n=2)	2.4±0.5** (n=5)	
4 weeks	130.0** (n=1)	113.3± 11.4** (n=4)	100.0** (n=1)	69.3±28.4** (n=4)	2.0** (n=1)	2.3±0.5** (n=4)	
8 weeks	121** (n=1)	115.0± 14.7** (n=4)	80.0** (n=1)	84.5±29.7** (n=4)	1** (n=1)	2.3±0.5** (n=4)	
12 weeks		119.7± 4.5** (n=3)		100** (n=3)		1.3±0.6** (n=3)	
24 weeks	125** (n=1)		89** (n=1)		1** (n=1)		

[a]Right hip joint, [b]Left hip joint
Significant difference between * and ** ($P<0.01$).
Data were expressed as mean ± SD.

not increased compared with preoperative diameters. In modified TPO, osteotomized iliac bone union completely occurred by 9.3±2.7 weeks.

Complications

The complications recorded in modified TPO were seroma formation (1 dog), loosening of screw (4 dogs), broken screw (1 dog) and unilateral neurapraxia (1 dog). In the group of unilateral TPO, seroma formation (1 dog) and broken screw (1 dog) were observed (Table 3).

Discussion

Clinical grades 24 weeks after modified TPO improved significantly ($P<0.01$). In unilateral TPO, postoperative clinical grade also improved. Therefore, there was no significant difference in clinical results on limb function treated with modified and unilateral TPO by short-term follow up period. It was reported that unilateral TPO[11,15] and bilateral TPO[2] were effective for the correction of hip dysplasia. Objective evaluation of limb function after TPO by force plate analysis and DJD scoring systems suggested that TPO eliminate lameness 6 month postoperatively[8].

Hip grades after modified TPO were significantly lower than preoperative hip grades ($P<0.01$), which was related with improved congruency of joint space and coverage rate of femoral head. However, the hip grades were not fully recovered to grade 1 during follow-up recheck period. This result was similar to previous reports advocating that TPO slackens, rather than prevent, the progression of DJD[8,12]

Norberg angle is 105° or greater in normal dogs. Reduced angle means femoral head subluxation or/and a shallow acetabulum according to the severity of hip dysplasia[9,14]. Therefore congruity of the femoral head and the acetabular margin, amount of coverage of the femoral head by the acetabular rim (at least 50% of the femoral head should be covered by the acetabulum.), remodeling and flattening of the femoral head are criteria for hip joint evaluation[4]. In the present study, Norberg angle and percentage of the femoral head coverage after modified TPO improved significantly ($P<0.01$) compared with preoperative values. After the acetabulum rotated following iliac osteotomy, a portion of acetabulum covering the femoral head increased and the origin of round ligament was located more medial position. Consequently, lateral dislocation of the femoral head and further injuries to joint cartilage or acetabular rim became preventable and osteoarthrosis would be delayed[7].

Pelvic narrowing was commonly observed in patients treated with unilateral TPO and brought about obstipation, dysuria secondary to malformation of pelvic canal[1,2]. In this study, pelvic diameter immediately after modified TPO increased significantly as compared with preoperative values ($P<0.01$). Three osteotomy sites, ilium, ischium, and pubis were around the acetabulum in unilateral TPO, but two, ilium and pubic symphysis in modified TPO. Therefore modified TPO could be more stable than unilateral TPO.

In modified TPO, 4 out of 36 (11%) dogs had loosening signs of implants in radiography. Among 432 screws, three were loosened and one was broken (0.9%). There was no evidence of plate breakage. While Simmons *et al*[17] reported that screw migration happened 33 to 36 % of dogs treated with TPO and application of ischial hemicerlcage wire in TPO was effective to avoid the loosening of screws. Remedios and Fries[13] showed that use of cerclage wire to the

ischial and iliac osteotomy was not concerned in preventing the loosening of screws. However in the present study, the cerclage wire around pubic symphysis was used for prevention of large motion of pubic symphysis.

The complications associated with unilateral TPO include femoral neck impingement, reduced abduction by overrotated acetabulum, narrowed pelvic canal inducing constipation and dysuria, implant failure, infection, introaoperative severe bleeding or iatrogenic nerve injury caused by mistakes in surgical technique, progressive DJD, persistent joint incongruity[13]. Additionally, there are also tenesmus, diarrhea, hematuria, incisional drainage, seroma formation, scrotal swelling, hematochezia[16]. Seroma formation (1 dog) and neurapraxia (1 dog) were generated after modified TPO in the present study, but these disappeared spontaneously. These complications were not considered to affect the prognosis.

CHD may be unilateral or bilateral and 70 to 97% bilateral affection has also been reported[4]. In bilateral dysplastic dogs, a number of authors prefer to operate both limbs at intervals of at least 2 to 4 weeks[8,12,15]. However, other study suggested 5 weeks after unilateral TPO. The load on untreated hip joints shifted from previously operated hip joint increased and untreated hip joint would be exposed to progression of DJD[11]. In the present study, one dog operated with unilateral TPO on the left hip joint showed worsening of untreated right hip joint 4 weeks after surgery. The operation time of modified TPO was significantly shorter than twice unilateral TPO and surgical approach of this technique is easier than that of unilateral TPO. These results demonstrated that modified TPO could be selected for the treatment of bilateral hip dysplasia in dogs.

Conclusion

The main goal of this study was to evaluate the effects of modified TPO that was developed to alleviate shortcomings of unilateral TPO

In modified TPO, 25 of 36 (69.4%) dogs stood without assistance from 4.9 days and walked from 7.3 days. Mean operation time was 143 minutes. This was shorter than time for twice unilateral TPO ($10^7 \times 2$ minutes). In 27 of 36 (75%) dogs with modified TPO, preoperative mean clinical grade was 2.3 ± 1.5. For 9 of these 27 dogs, mean clinical grade 24 weeks postoperatively was 3.2 ± 0.7 and this was significantly higher than preoperative clinical grade ($P<0.01$).

In modified TPO, radiographic hip grades until 24 weeks after surgery were significantly lower than preoperative hip grades ($P<0.01$). Mean values for percentage of femoral head coverage, Norberg angle until 24 weeks after surgery also increased significantly ($P<0.01$). There were a few complications, such as seroma formation (1 dog), loosening of screw (4 dogs), broken screw (1dog) and temporary unilateral neurapraxia (1 dog) in modified TPO. But, dysuria and constipation secondary to the deformation of pelvis, over-coverage of acetabulum, instability/non-union of osteotomy sites were not observed.

It may be taken into consideration that modified TPO is an effective technique for the treatment of hip dysplasia in dogs.

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개의 고관절 이형성 치료를 위한 변형 3중 골반 절골술의 적용

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요 약 : 개의 양측성 고관절 이형성을 치료하기 위해 실시하는 슬로컴의 편측 3중 골반 절골술을 개선하기 위해 고안된 변형 3중 골반 절골술의 효과에 대해 알아 보고자 본 연구를 실시하였다. 변형 3중 골반 절골술은 양측 장골 절골술과 치골결합 절골술을 동시에 실시하는 방법이다. 변형 3중 골반 절골술을 실시한 36마리와 편측 3중 골반 절골술을 실시한 7마리의 개에 대한 품고, 체중, 수술 시간, 골 유합기간, 복합증 등의 자료를 조사, 기록하였다. 임상 증상과 고관절 이형성의 등급, Norberg angle, percentage of femoral head coverage, 골반 직경에 대해 수술 전, 직후, 수술 후 2, 4, 8, 12, 24주에 각각 측정, 기록하였다. 편측 3중 골반 절골술을 실시한 개체의 평균 연령과 체중은 각각 9.0 ±4.9개월, 24.8±7.5 kg (n=7)이었다. 수술 후 평균 3.0±1.0일에 스스로 일어서고 8.3±0.6일부터는 걸을 수 있었다(n=3). 수술 전과 24주 후의 평균 임상 증상 등급은 각각 2.2±0.42 (n=6), 3.5±0.7 (n=2)이었다. 평균 수술 시간은 107.3±38.9분 (n=4)이었다. 변형 3중 골반 절골술을 실시한 개체의 평균 연령과 체중은 각각 8.7±3.0개월, 26.9±7.6 kg (n=36)이었다. 이중 25마리는 수술 후 평균 4.9±3.7일부터 스스로 일어날 수 있었고 평균 7.3±4.8일 후부터 보행이 가능하였다. 변형 3중 골반 절골술을 실시한 개체의 수술 전과 24주 후의 평균 임상 증상 등급은 각각 2.3±1.5 (n=27), 3.2±0.7 (n=9)로 수술 전보다 유의적으로 개선되었다($P<0.01$). 평균 수술 시간은 143±42.8분(n=24)으로 두 번의 편측 3중 골반 절골술보다 단축되었다. 변형 3중 골반 절골술을 실시한 개체의 수술 전 방사선학적 평균 고관절 등급은 양측 모두 3.2±0.9이었고 수술 직후의 좌·우측 평균 고관절 등급은 각각 2.7±1.1, 2.7±0.9 (n=36)이었다. 수술 직후와 2, 4, 8, 12, 24주 후의 고관절 등급이 수술 전에 비하여 유의적으로 개선된 것을 확인하였다($P<0.01$). 수술 후 정기적인 검사 시에 측정한 Norberg angle, percentage of femoral head coverage도 수술 전과 비교해 유의성 있게 증가하였다($P<0.01$). 변형 3중 골반 절골술 직후의 평균 골반직경은 수술 전의 골반직경보다 유의적으로 증가하였으며($P<0.01$)(n=36) 수술 후 평균 9.3±2.7주에 절골선 유합이 종료되었다(n=21). 반면 편측 3중 골반 절골술을 실시한 경우에는 수술 후 골반경이 수술 전과 비교해 증가하지 않았다. 변형 3중 골반 절골술후에 장액종 형성(1마리), 스크류 변위(4마리), 스크류 부러짐(1마리), 편측성 신경마비(1마리) 등의 부작용이 발생하였다.이상의 결과를 토대로, 변형 3중 골반 절골술은 개의 고관절 이형성의 효과적인 치료 방법이라 사료된다.

주요어 : 고관절 이형성, 개, 변형 3중 골반 절골술.