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RESEARCH ARTICLE

Clinical, Radiological and Computed Tomographic Evaluations of the Effect of Triple Pelvic Osteotomy for Treatment of Canine Hip Dysplasia [1] [2] [3]

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Summary

Triple pelvic osteotomy (TPO) is one of the main surgical procedures to prevent or modify the progress of degenerative joint disease (DJD) related with hip dysplasia in young dogs. The aim of this study was to evaluate the effects of TPO in dogs. In this study, TPO were performed in 7 dysplastic cross-breed dogs in different gender (6 female and 1 male) and body weight (13.42±2.29 kg). In all cases, 20 degrees canine TPO plates were used. Before the operation, all cases were examined clinical, radiological and by computed tomographic. Postoperative 2nd and 6th weeks dogs were examined clinical, radiological and by computed tomographic and after 6 month both clinical and radiological examinations were performed. The joint laxity decreased 2 weeks after the operation. Dogs could walk on the treated leg after 2 weeks. The joint laxity decreased 2 weeks after the operation. Postoperatively dogs could walked on the treated leg after 2 weeks. The postoperatively measured Norberg angles ($P<0.01$) and acetabular anteversion angle ($P<0.05$) were significantly higher and distance between caput femoris and acetabulum was significantly lower ($P<0.05$) than preoperatively measurements. So, contact surface between the femoral head and the acetabulum had increased and the subluxation had disappeared. In radiographs obtained 6 months later, degenerative joint disease was not encountered. It was decided that canine hip dysplasia, could be treated successfully in young dogs via TPO, carried out before degenerative changes begin within the hip joints.

Keywords: *Hip dysplasia, Triple pelvic osteotomy, Radiological, Computed tomography, Dog*

Köpeklerde Kalça Displazisi'nin Sağaltımında Triple Pelvik Osteotomi Etkilerinin Klinik, Radyolojik ve Bilgisayarlı Tomografi ile Değerlendirilmesi

Özet

Triple pelvik osteotomi (TPO) genç köpeklerde kalça displazi ile ilgili dejeneratif eklem hastalığı (DJD)'nın ilerlemesini önlemek ve değiştirmek için uygulanan cerrahi bir işlemdir. Bu çalışmanın amacı, köpeklerde TPO'nun etkilerini araştırmaktır. Bu çalışmada, farklı cinsiyet (6 dişi, 1 erkek) ve vücut ağırlığındaki (13.42±2.29 kg) displazik 7 köpekte TPO yapıldı. Bütün olgularda, 20° canin TPO plağı kullanıldı. Operasyon öncesi tüm olguların klinik, radyolojik ve bilgisayarlı tomografi ile muayeneleri yapıldı. Köpekler operasyon sonrası 2. ve 6. haftalarda klinik, radyolojik, bilgisayarlı tomografik muayene ve 6 ay sonra hem klinik hem de radyolojik muayeneleri yapılarak takip edildi. Operasyondan 2 hafta sonra eklem gevşekliği azaldı. Köpekler operasyon sonrası 2 haftada tedavi edilen bacakları üzerinde yürüyebiliyorlardı. Postoperatif ölçülen Norberg açıları ($P<0.01$) ve asetabular antreversiyon açısı ($P<0.05$) preoperatif değere göre yüksekti ve kaput femoris ve asetabulum arasındaki mesafe belirgin olarak düşük bulundu. Bu nedenle, asetabulum ve kaput femoris arasındaki temas yüzeyi artarak, subluksasyon kayboldu. Altı ay sonra elde edilen radyografilerde, dejeneratif eklem hastalığına rastlanmadı. Kalça displazili genç köpeklerde kalça ekleminde dejeneratif değişiklikler başlamadan yapılan TPO ile başarılı bir şekilde tedavi sağlanabileceği sonucuna varıldı.

Anahtar sözcükler: *Kalça displazisi, Triple pelvik osteotomi, Radyoloji, Bilgisayarlı tomografi, Köpek*

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INTRODUCTION

Canin hip dysplasia (CHD) is an inherited, developmental orthopedic disease of the hip joint, affect the puppies of large and giant breed dogs [1-4]. The dogs are born with normal hip joint. During growth, there may be incoordination between the skeleton and the supporting muscle system [1]. The earliest clinical sign of the disease is hip joint laxity. In the later stages of the disease, clinical symptoms such as swinging, exercise intolerance, atrophy of the muscules of the hind limbs are seen [3,5]. In the treatment of hip dysplasia, conservative or surgical methods are used depending on the age and body weight of the animal, the physical and radiologial finding and the financial status of the patient owner. Many surgical procedures (total hip replacement, excision arthroplasty, triple pelvic osteotomy, juvenil pubic symhysiodesis etc.) for treatment of HD have been reported [6-9]. Triple pelvic osteotomy is frequently used for the treatment of hip dysplasia in immature dogs. The ideal candidates for triple pelvic osteotomy should have minimal to no degenerative osteoarthritis seen on radiographs and positive Ortolani sign [8,10]. The primary objective of this surgery is to improve joint stability by rotating the dorsal rim of the acetabulum laterally, thus providing greater dorsal coverage of the head.

MATERIAL and METHODS

A total of 110 hip joint of 55 cross-breed dogs, of different ages and gender, were examined in this study. Following clinical, radiological and tomographic examinations *(Fig. 1)*, hip dysplasia was diagnosed in a total of 7 dogs (6 females, 1 male) and those which degeneration had not yet begun in the joint, were selected for surgery. General anaesthesia was applied with 1.1 mg/kg xylazine HCl (Alfazine®, 20 mg/ml, Ege-Vet, Izmir, Turkey) and 10 mg/kg ketamine HCl (Alfamine®, 100 mg/ml, Ege-Vet, Izmir, Turkey) intramuscularly after premedication with 0.04 mg/kg atropine sulphate (Atropan®, 2 mg/ml, Vetas, Istanbul, Turkey) subcutaneously. Operation site was shaved and disinfected in a routine manner. For the ostectomy of the pubis, the related leg was held at a position of 90º abduction and a 4-5 cm skin incision was made starting from pubis on the inside of the leg between pectineus muscle and gracilis muscle, perpendicular to the median line. The origin of the pectineal muscle was isolated by dissection and after separation, including the periosteum, of the part attached to the area of pubis to be ostectomized together with abductor magnus muscle and other soft tissue, the pubis was cut and a 1-2 cm long piece of bone was removed from the pubis ramus. For the ischial osteotomy, a 4-6 cm long skin incision was made parallel to tuber ischiadicum, from the lateral aspect to the starting point of arcus ischiadicum. A part of the internal obturator muscle connection to tuber ischiadicum was elevated and the foramen obturatorium was reached. After sufficient space

Fig 1. Ventrodorsal radiograph of pelvis before TPO (case 3)
Şekil 1. TPO'dan önce pelvis'in ventrodorsal radyografisi (olgu 3)

was achieved, an osteotomy was done on the ischii from the outside towards the inside, parallel to the longitudinal axis of the pelvis. For the iliac osteotomy and placement of the Canine Osteotomy Plate, a 10-15 cm skin incision was made between the wing of the ilium to the greater trochanter. Subcutaneous adipose tissue and gluteal fascia were dissected, the middle and the deep gluteal muscles were elevated. The body of the ilium was reached. An ilial osteotomy was carried out immediately on the caudal of the sacroiliac joint, protecting isciadic nerve.

After osteotomy, Canine Osteotomy Plates with an angle 20º were placed. Following placement of the plate, ischial osteotomy line was fixed using cerclage wire [6]. The operated areas were surgically closed. Immediately after the operation, symmetrical VD radiographs were taken. All cases were given penicilline G 20.000 IU/BW/day (Iecilline 400.000 İÜ, İ.E. Ulagay® Istanbul) during a week after the operation. Weekly clinical and radiological examinations, and computed tomographic examinations at the 2nd and 6th weeks were performed.

Radiographs examinations were taken in standart ventrodorsal (VD) positions. Degenerative changes on the caput femoris and acetabulum, Norberg angle and implant status

were evaluated. Computed tomographical examinations were taken in ventro-dorsal positions. Acetabular anteversion angle (AAA**)**, the perpendicular distance from the center of the femoral head and midpoint of the line which connecting the cranial and caudal corner of the acetabulum (a), the perpendicular distance from the most lateral point of the femoral head and midpoint of the line which connecting the cranial and caudal corner of the acetabulum (b) were measured from computed tomographic (CT) scans.

Kruskal Wallis Test was used for statistical comparison of data obtained radiological and Computed tomographical examinations performed in preoperative, early and late postoperative periods, while Duncan test was used to determine group/groups causing difference among groups.

RESULTS

TPO were performed in 7 dysplastic cross-breed dogs in different gender (6 female and 1 male) and body weight (13.42±2.29 kg). In preoperative clinical examination, physical findings such as difficulty in walking upstairs, a swinging gait, bunny hopping and laxity in the hip joint were observed. Positive and negative ortolani test were determined in 4 and 3 dogs respectively.

Dogs could able to used treated leg after 2 weeks. The joint laxity decreased 2 weeks after the operation. Postoperative complications were observed such as skin sutures opening in the area of the ischial osteotomy (cases III, VI) and sciatic paralysis (cases II, IV, VII). The wounds presented no further complications after having been reopened, cleaned and sutured again. Sciatic paralysis cases were improved within two weeks in two cases.

Radiographical *(Fig. 2, 3* and *4)* and computed tomography

Fig 3. Postoperative 2nd week (case 7)
Şekil 3. Postoperatif 2. hafta (olgu 7)

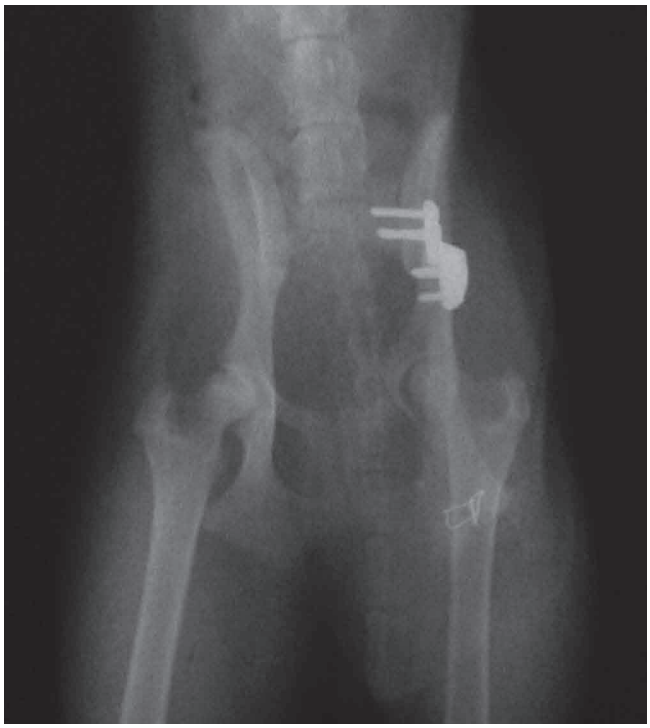

Fig 2. Postoperative 1st day (case 4)
Şekil 2. Postoperatif 1. gün (olgu 4)

Fig 4. Postoperative 6th week (case 3)
Şekil 4. Postoperatif 6. hafta (olgu 3)

Table 1. *Measurements taken from CT Scans*
Tablo 1. *Bilgisayarlı Tomografi taramalarından elde edilen ölçümler*

Parameters	Preoperative X±sX	Postoperative 2nd week X±sX	Postoperative 6th week X±sX	X²
Norberg Angle (Radiographical)	99.14±0.59[b] (96-100)	120.71±3.85[a] (105-130)	124.29±2.97[a] (110-130)	14.36**
Acetabular Anteversion Angle	27±2.36[b] (19-34)	52.71±6.67[a] (28-70)	54.57±5.72[a] (30-74)	8.83*
Acetabular Coverage(%)	43.74±2.30 (31.93-50.0)	46.18±1.39 (41.56-52.41)	47.69±1.04 (44.05-51.79)	1.99
A (mm)	2.64±0.28[a] (1.60-4.0)	1.97±0.14[b] (1.50-2.70)	1.67±0.23[b] (0.4-2.20)	6.510*
B (mm)	8.95±0.42 (8.0-11.30)	8.54±0.19 (7.90-9.20)	8.40±0.19 (7.80-9.40)	1.078

*** P<0,01 * p<0.05;* ***A (mm):*** *The perpendicular distance from the center of the femoral head and midpoint of the line which connecting the cranial and caudal corner of theacetabulum;* ***B (mm):*** *The perpendicular distance from the most lateral point of the femoral head and midpoint of the line which connecting the cranial and caudal corner of the acetabulum;* ***a,b:*** *There is istatistical difference between groups in the same line with different letters*

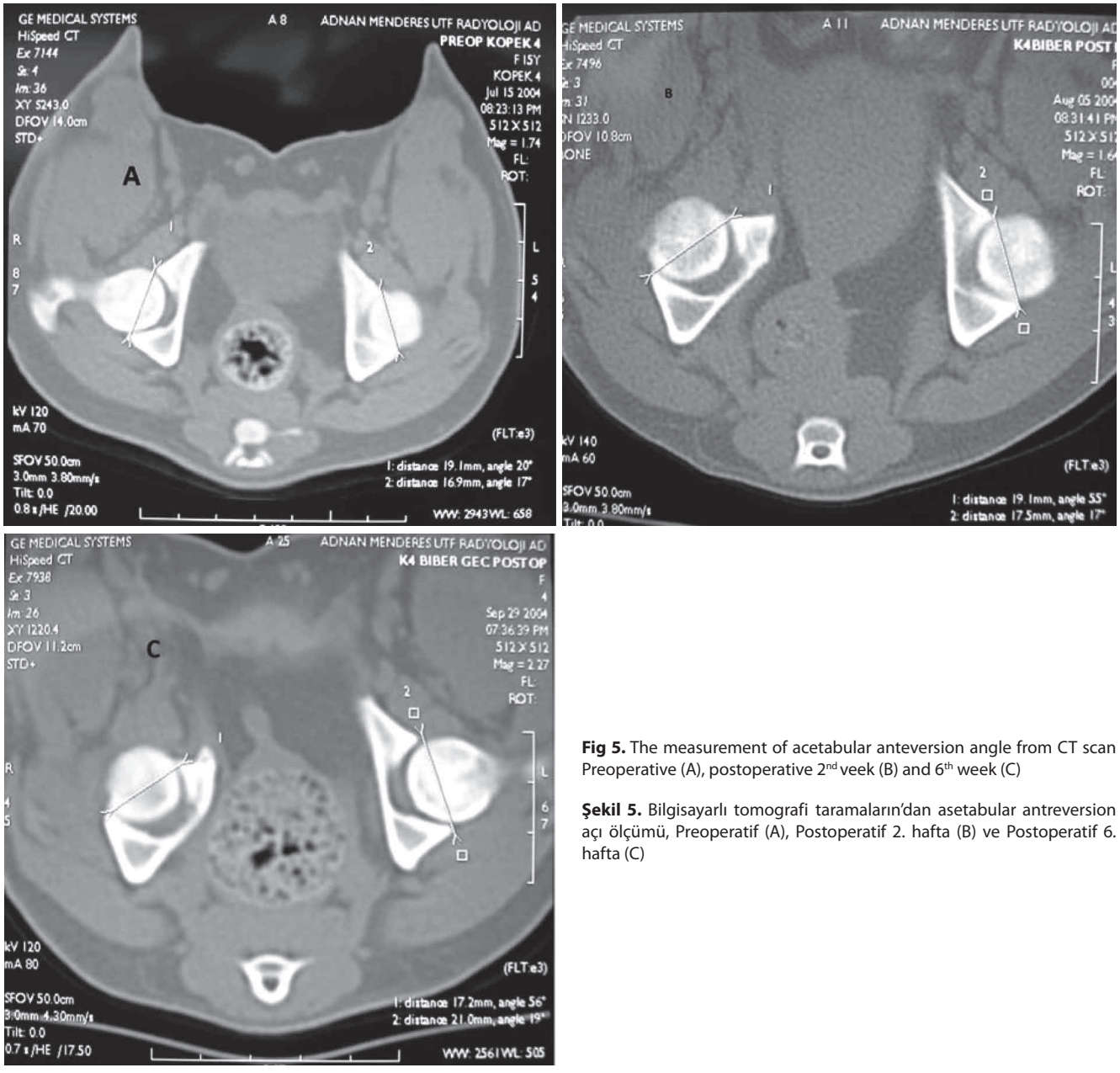

Fig 5. The measurement of acetabular anteversion angle from CT scan Preoperative (A), postoperative 2nd veek (B) and 6th week (C)

Şekil 5. Bilgisayarlı tomografi taramaların'dan asetabular antreversion açı ölçümü, Preoperatif (A), Postoperatif 2. hafta (B) ve Postoperatif 6. hafta (C)

findings *(Fig. 5* and *6)* were shown *Table 1*. The mean Norberg angles were 99.14±0.59 (96-100) preoperative, 120.71±3.85 (105-130), 124.29±2.97 (110-130) postoperative, 2nd and 6th weeks, respectively.

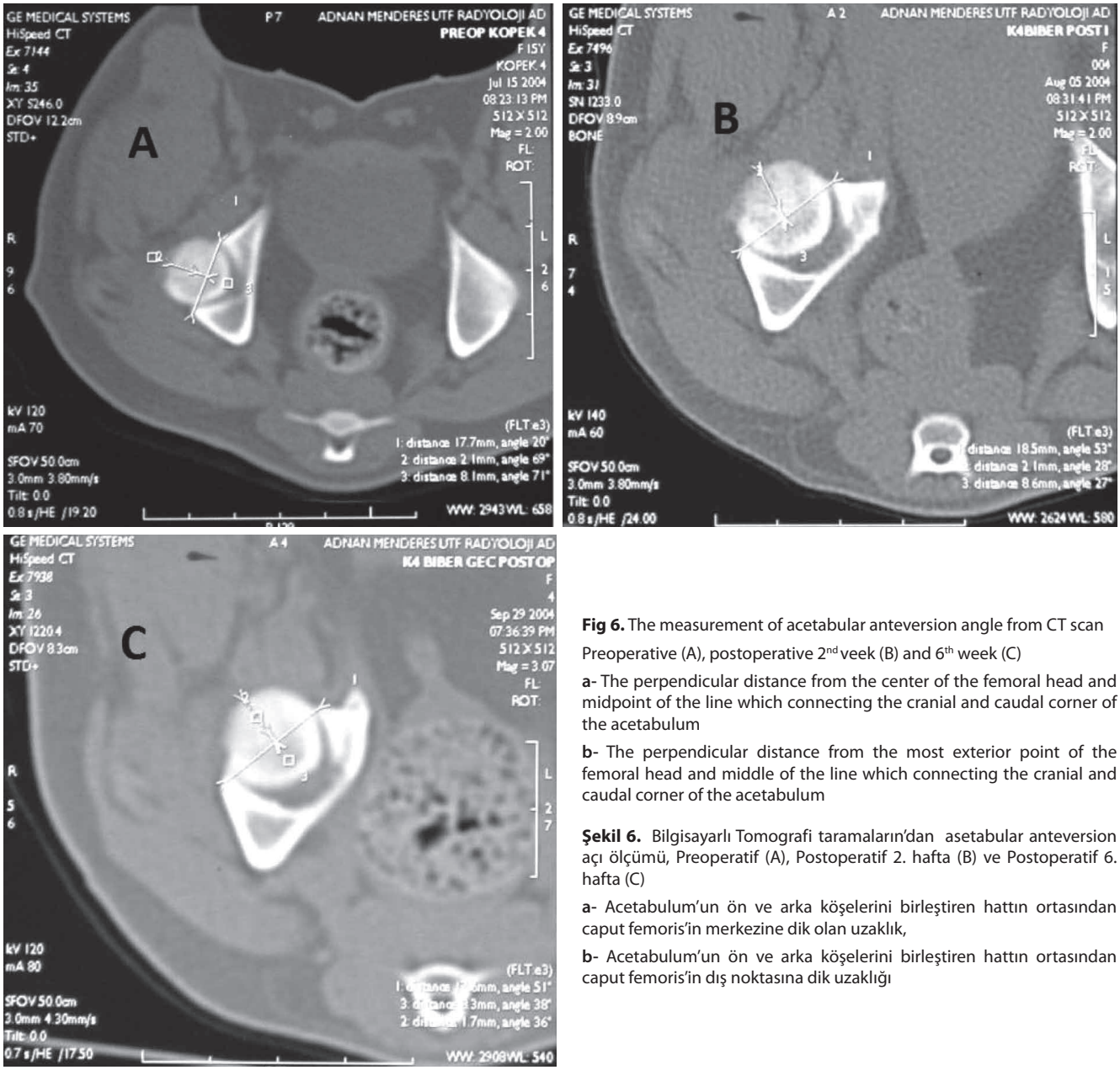

Fig 6. The measurement of acetabular anteversion angle from CT scan

Preoperative (A), postoperative 2nd veek (B) and 6th week (C)

a- The perpendicular distance from the center of the femoral head and midpoint of the line which connecting the cranial and caudal corner of the acetabulum

b- The perpendicular distance from the most exterior point of the femoral head and middle of the line which connecting the cranial and caudal corner of the acetabulum

Şekil 6. Bilgisayarlı Tomografi taramaların'dan asetabular anteversion açı ölçümü, Preoperatif (A), Postoperatif 2. hafta (B) ve Postoperatif 6. hafta (C)

a- Acetabulum'un ön ve arka köşelerini birleştiren hattın ortasından caput femoris'in merkezine dik olan uzaklık,

b- Acetabulum'un ön ve arka köşelerini birleştiren hattın ortasından caput femoris'in dış noktasına dik uzaklığı

The mean percentage of acetabular coverage were 43.74±2.30% (31.93-50.0), 46.18±1.39% (41.56-52.41), 47.69±1.04% (44.05-51.79), in same periods. The post-operatively measured Norberg angles ($P<0.01$) and acetabular anteversion angles ($P<0.05$) were significantly higher and distance between femoral head and acetabulum was significantly lower ($P<0.05$) than preoperatively measurements.

In radiographic examination performed 6 months later postoperatively, DJD was not encountered.

DISCUSSION

While several methods are known for the surgical treatment of hip dysplasia, TPO appears to be increasingly used in the last years [11-14]. In order to obtain desired results with TPO, patient should be young and free from degenerative changes of the hip joint, or at the very least with only a minimal level of such changes [11,12]. All dogs in this study had no clinical and radiological finding related with hip joints at the beginning of the study.

There is no consensus about sex predisposition on CHD. Hara et al.[15] reported an incidence of 25% females 75% in the male dogs. Bakır [16] have been reported that hip dysplasi were 29.56% in males, 39.06% females in dogs. A total of 55 dogs were examined in this study. 85% of the dysplasia dogs were female and 15% were male. These results were reported by Bakır [16]. We considered that it would be inappropriate to formulate an opinion, considering the small number of cases.

Dogs with hip dysplasia are generally described as having trouble walking upstairs, bunny happing, standing up with difficulty and showing a laxity of the hip joint. It is also reported that laxity of the hip joint is established in the case of a positive Ortolani test, while a negative test does not indicate that the hip is healthy because of the occasional false positive and false negative results [11,17,18]. Similar clinical results were found in all dogs in this study. The Ortolani test was positive in nine hips and negative in five. A parallelism between these findings and the Norberg angle was also noted.

Radiological examination is used in the diagnosis of hip dysplasia. In symmetrical ventro-dorsal (VD) radiographs, joints have a Norberg angle over 105 and those with more than 50% of the femoral head inside the acetabulum are considered to be normal [19]. A definite post-operative increase in both the Norberg angle and the femoral head portion that fits in the acetabulum is reported for dogs undergoing TPO surgery [12,20]. In this study, the post-operatively measured Norberg angles ($P<0.01$) and acetabular anteversion angles ($P<0.05$) were significantly higher and distance between caput femoris and acetabulum was significantly lower ($P<0.05$) than pre-operatively measurements. In all cases, both the clinical and the radiological findings showed an improvement when compared to the pre-operative status.

In the light of data on the tomographic appearance of the hip joint in both normal and dysplastic hip [21], dogs with hip dysplasia in this study had been evaluated by computed tomography as well as in the early and late post-operative periods. When basing the evaluation on length measurements, some changes were seen also in the unoperated hip joints. It was thought that this difference may be due to the fact that the at slice sections, which are 3 mm apart, did not correspond to the same points in the different examinations. The distance from the center of the femoral head to the midpoint of the line that joins the anterior and posterior corners of the acetabulum (a) was seen to be statistically smaller than before the operation both at the 2-week and the 6-week follow-up measurements ($P<0.05$). As for the distance from the midpoint of the line between the anterior and posterior corners of the acetabulum (b), there was no significantly change even though there was a certain post-operative decrease. Statistically significant increase ($P<0.01$) was established at both post-operative follow-ups in the acetabular ante-version angle (AAA). These findings lead us to think that the use of angular measures, and even numeric values resulting from the comparison of certain structures within the field of interest which may remain stable, may be subject in the dogs is seen.

Complications reported for TPO surgery include diarrhea, bloody feces, hematuria, incision discharge, scrotal swelling and sciatic nerve paralysis [6,12,22]. Altunatmaz et al.[12] reported that paralysis of sciatic nerve was observed in 3 cases and a collection occurred at the ischii osteotomy In 1 case of 22 cases. The wounds presented no further complications after having been reopened, cleaned and sutured again. As for the sciatic nerve paralysis, two of these cases improved within the week while the third dog (case 7) showed no such improvement.

Borostyankoi et al.[23] report that the majority of their 95 dogs could stand 24 h after undergoing a bilateral TPO; the average length of hospitalization was 7.5 days. In this study, we observed that, owing to the unilateral nature of the interventions, all cases could stand without help 24 hours after surgery. The dogs continued to be observed for a longer period because of the study protocol. The prolonged observation of the animals facilitated post-operative care while allowing early recognition and early treatment of the complications. It was concluded that prolonged observation of patients following this, or similar, interventions.

Following TPO surgery male dogs may experience difficulties in lifting their hind leg to urinate, a situation that may be due to the friction of the femoral head on the dorsal acetabular wall [24], or to excessive tension of the pectineus muscle [12]. Even though it is not possible to conclude with the single male subject in our study, similar problem was observed in this patient during the first two post-operative days; the animal was later able to easily lift its hind leg. This may also have been caused by the operation's site pain.

Following TPO in dogs, the most frequently complications are observed pelvic canal narrowing and screw loosening [6,22-26]. Screw loosening being encountered in 33-36% of cases [22]. Certain investigators report that hemicerclage of the ischial osteotomy line reduces screw loosening [22], while others indicate that applying cerclage to either the ischial or ilial osteotomy lines has no such effect [27]; Altunatmaz et al.[12] propose that 20 days or longer movement restriction may be helpful in this circumstances. All cases undergoing TPO in our study were kept in individual cages with their movements restricted; none presented any problems related to the screws or plates. These considerations show that good postoperative observation and follow-up are imporatl for reduce post-operative complications.

Contrary to some investigators who reported that DJD change continues to progress following TPO [11,23], others indicate that such changes stop after the operation [12,28]. No degenerative changes were observed in any of the animals in our study either before the operation, or at the early or late postoperative follow-up.

Most commonly used canine pelvic osteotomy plates are available in three angles 20°, 30°, 40°. However, several authors suggests that the use of TPO procedure should be avoided where plates with extreme angles of rotation are

required [29-31]. The more extreme angle of rotation of the acetabulum, the more risk there is of interference between the femoral neck and the dorsal acetabular rim, and also reduces congruency, due to articular cartilage being thicker centrally on the femoral head and peripherally in the acetabulum [32]. Altunatmaz et al.[11] report that the animals in whom 40º plates were experienced obvious narrowing of the pelvic canal, while this effect was rather mild following use of 20° plates. This narrowing, however, did not cause any inconvenience to the subjects. In our study, we observed that the pelvic canal narrowing observed in the early post-operative follow-up improved in the later stages. This result may be due to a combination of the unilateral nature of the operation in all cases, and the uniform use of 20º plates.

The result of this research suggested that canine hip dysplasia, could be treated successfully in young dogs via TPO, carried out before degenerative changes begin within the hip joints.

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