EFFECTIVENESS OF MODIFIED CHIARI OSTEOSIS
AND INTERTROCHNATERIC OSTTEOTOMY
IN THE TREATMENT OF CANINE HIP DYSPLASIA

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Abstract

This paper describes the results of Chiari osteotomy (CO) with simultaneous intertrochanteric osteotomy (IO) in dogs affected by bilateral hip dysplasia, score grade D. The dogs classified for the study were subjected to the following tests before and after surgery: abduction-external rotation test, hip extension test, dorso-lateral subluxation test (DLST), stand test, Ortolani sign, Barlow sign, measurements of the angle of flexion, angle of extension, angle of abduction, angle of adduction, and radiographic examinations determining the score grade for canine hip dysplasia in accordance with the scoring system recommended by the Fédération Cynologique Internationale. The test which most accurately reflected the post-operative improvement in patients was DLST where the negative response increased by 73% after CO and IO procedures. Changes in angle of inclination (AI) values were correlated with an improvement in hip functioning as a result of the administered treatment. The simultaneous application of CO and IO in dogs affected by hip dysplasia resulted in greater improvement of limb functioning in comparison with conventional IO.

Key words: dog, hip dysplasia, Chiari osteotomy, intertrochanteric osteotomy.

Canine hip dysplasia (CHD) is a congenital hereditary disease, which usually affects both hip joints. It is a progressive disease that leads to the development of osteoarthritis (1, 7). Various surgical techniques are used in the treatment of CHD, including osteotomy. Chiari osteotomy (CO) is applied in the surgical treatment of hip joint dysplasia, congenital dislocation of the hip joint, hip joint dislocation resulting from the Legg-Calve-Perthes disease, and valgus deformity of the hip joint in humans and dogs (2, 4, 5). The aim of the presented study was to medialise the pelvic acetabulum, to expand the rim of the acetabulum of the hip joint and increase the acetabular coverage of the femoral head (4, 5, 10).

Intertrochanteric osteotomy (IO) is used in the treatment of CHD, defects in the angle of inclination and anteverision, and hip joint valgisation in dogs. In CHD, the aim of the IO is to reduce the angle of inclination of the femoral neck (14). The objective of this study was to determine diagnostic parameters, which are most closely correlated with an improvement in the functioning of the operated limbs and the welfare of dogs affected by hip dysplasia after CO and IO procedures.

Material and Methods

In 2004-2009, simultaneous CO and IO procedures were carried out in 11 unsterilized dogs of different breeds, both sexes, aged 12-24 months, with body weight of 25-31 kg. The animals were subjected to the following examinations:

- pain tests on conscious animals - abduction-external rotation test (ART), hip extension test (HET), dorsal-lateral subluxation test (DLST), and stand test (ST);
- orthopedic tests on unconscious sedated animals - Ortolani sign (OS), Barlow sign (BS), angle of flexion of the hip joint (AF), angle of extension of the hip joint (AE), angle of abduction of the hip joint (AB), and angle of adduction of the hip joint (AD);
- radiological examinations of the hip joint to determine the CHD score grade in accordance with the grading system developed by the FCI (11, 15, 16).

Angle measurements were performed with the use of a Saehan goniometer. The severity of dysplasia was determined with the involvement of Riser's method, and the angle of inclination of the femoral head was measured (8, 13, 15). Orthopedic examinations and tests requiring sedation and anesthesia were performed using atropine sulfate (WZF Polfa, Poland) at 0.05 mg/ kg

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b.w., s.c., and acepromazine (Vetoquinol, France) at 0.5 mg/kg b.w., i.m. All the dogs were subjected to unilateral CO modified by the authors and unilateral IO. Prior to halothane anaesthesia, the patients were premedicated with atropine sulfate at 0.05 mg/kg b.w., s.c., buprenophinum (WZF Polfa, Poland) at 0.005 – 0.02 mg/kg b.w. i.v., and an induction of xylazine (Vetoquinol, France) at 2 mg/kg b.w., i.v., and ketamine (Vetoquinol, France) at 5 mg/kg b.w., i.v. The surgical site was accessed and tissues were separated in accordance with standard procedures (12-14). The CO technique (5, 9) was modified by incising the body of the ilium in an oblique rather than a perpendicular fashion relative to the long axis, and by placing additional bone wedges at the place of incision. Bone wedges measuring 30 mm x 25 mm x 10 mm for bolting the incision crevice were sampled intraoperatively from the wing of the ilium (17). An oblique incision in the body of the ilium and the wedging of the incision crevice with autografts supported the repositioning of the displaced ends of the body of the ilium without the use of metal implants. The femoral head was centralised by classic IO (14). Post-IO stabilisation was performed with the use of an angle plate (Mikromed, Poland). The head of the angle plate was inserted into an opening in the greater trochanter along the axis of the femoral neck. The plate was attached to the femoral shaft with three 4.5 mm bone screws (Mikromed, Poland) (Fig. 1).

The limb was stabilised postoperatively with rigid cast dressing. The patients were administered antibiotic cover – cepalexin (Vetoquinol, France) in the amount of 10 mg/kg b.w. Postoperative pain was managed with tolfenamic acid (Vetoquinol, France) at 4 mg/kg b.w. for 6 d. Orthopedic tests and radiological examinations were performed 12 months after treatment to verify the results of surgery.

**Results**

This paper contains a retrospective analysis of CO and IO results in dogs affected by bilateral hip dysplasia, score grade D. During clinical examination, the third and fourth degree lameness of the hind limbs (on Millis' five-point grading scale) was diagnosed in all patients at rest and after exercise (11).

The results of tests performed before CO and IO procedures are presented in Tables 1, 2, and 3, and in Figs 2 and 3.

The results of tests performed after CO and IO procedures are presented in Tables 4, 5, and 6, and in Fig. 3.

Soft tissues and the osteotomised ilium healed correctly in all patients (Fig. 4). In this experiment, the inclusion of IO in the surgical procedure supported the centralisation of the femoral head in the pelvic acetabulum. After eight weeks of rehabilitation (11), the examined dogs spread their body weight evenly across all four limbs. Following rehabilitation, dog owners did not report any instances of lameness at rest, after exercise, or at walk. Transient lameness of the first degree (Millis scale) (11) was noted in three dogs up to six months after surgery. The owners attributed the above to weather changes.

A clinical examination indicated a full range of joint mobility permitting free and painless movement. A radiological examination demonstrated an absence of surface area congruence and hip joint subluxation. The surgical reconstruction of the pelvis and healing did not reverse mediatisation after osteotomy. Postoperative pelvic remodelling prevented repeated radiological investigation of the degree of dysplasia.

**Table 1**

<table>
<thead>
<tr>
<th>Parameter</th>
<th>ART</th>
<th>HET</th>
<th>DLST</th>
<th>ST</th>
<th>OS</th>
<th>BS</th>
</tr>
</thead>
<tbody>
<tr>
<td>n (+)</td>
<td>n (+)</td>
<td>10</td>
<td>1</td>
<td>9</td>
<td>2</td>
<td>11</td>
</tr>
<tr>
<td>n (−)</td>
<td>n (−)</td>
<td>1</td>
<td>1</td>
<td>9</td>
<td>2</td>
<td>11</td>
</tr>
</tbody>
</table>

n – number of dogs, (+) (-) – test result; ART - abduction-external rotation test, HET - hip extension test, DLST - dorsal-lateral subluxation test, ST - stand test, OS - Ortolani sign, BS - Barlow sign.

![Fig. 1. Postoperative radiographic view.](image-url)
Table 2
Range of hip joint mobility determined before CO and IO

<table>
<thead>
<tr>
<th>Parameter (reference value)</th>
<th>$x^\circ$</th>
<th>n</th>
<th>AF° (55°)</th>
<th>AE° (160-165°)</th>
<th>AB° (120°) *</th>
<th>AD° (65°) *</th>
</tr>
</thead>
<tbody>
<tr>
<td>x°</td>
<td>n</td>
<td>55-60</td>
<td>2</td>
<td>130-150</td>
<td>8</td>
<td>100-110</td>
</tr>
<tr>
<td>x°</td>
<td>n</td>
<td>60-70</td>
<td>9</td>
<td>150-170</td>
<td>3</td>
<td>115-120</td>
</tr>
</tbody>
</table>

$x^\circ$ - angle, n – number of dogs; * - measurement at 90° flexion angle in stifle joint; AF - angle of flexion of the hip joint, AE - angle of extension of the hip joint, AB - angle of abduction of the hip joint, AD - angle of adduction of the hip joint.

Table 3
Angle of inclination (AI) determined before CO and IO

<table>
<thead>
<tr>
<th>Group</th>
<th>$x^\circ$ AI</th>
<th>n</th>
<th>a</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>162</td>
<td>2</td>
<td>very poor</td>
</tr>
<tr>
<td>B</td>
<td>161</td>
<td>2</td>
<td>very poor</td>
</tr>
<tr>
<td>C</td>
<td>160</td>
<td>2</td>
<td>very poor</td>
</tr>
<tr>
<td>D</td>
<td>158</td>
<td>3</td>
<td>poor</td>
</tr>
<tr>
<td>E</td>
<td>155</td>
<td>2</td>
<td>poor</td>
</tr>
</tbody>
</table>

$x^\circ$ - angle, n – number of dogs, a – owners' opinion about the limb functionality before treatment

Fig. 2. AI values in experimental groups in % before CO and IO

Table 4
Results of tests performed after CO and IO

<table>
<thead>
<tr>
<th>Parameter result</th>
<th>ART</th>
<th>HET</th>
<th>DLST</th>
<th>ST</th>
<th>OS</th>
<th>BS</th>
</tr>
</thead>
<tbody>
<tr>
<td>n (+)</td>
<td>5</td>
<td>6</td>
<td>5</td>
<td>3</td>
<td>1</td>
<td>10</td>
</tr>
<tr>
<td>n (-)</td>
<td>6</td>
<td>6</td>
<td>5</td>
<td>8</td>
<td>1</td>
<td>10</td>
</tr>
</tbody>
</table>

n – number of dogs, (+) (-) – test result; abbreviations are explained in the footnote to Table 1.

Table 5
Range of hip joint mobility determined after CO and IO

<table>
<thead>
<tr>
<th>Parameter (reference value)</th>
<th>$x^\circ$</th>
<th>n</th>
<th>AF° (55°)</th>
<th>AE° (160-165°)</th>
<th>AB° (120°) *</th>
<th>AD° (65°) *</th>
</tr>
</thead>
<tbody>
<tr>
<td>x°</td>
<td>n</td>
<td>55-60</td>
<td>0</td>
<td>130-150</td>
<td>6</td>
<td>100-110</td>
</tr>
<tr>
<td>x°</td>
<td>n</td>
<td>60-70</td>
<td>11</td>
<td>150-170</td>
<td>5</td>
<td>115-120</td>
</tr>
</tbody>
</table>

$x^\circ$ - angle, n – number of dogs; * - measurement at 90° flexion angle in stifle joint; abbreviations are explained in the footnote to Table 2.
Positive ST results are not characteristic of hip joint dysplasia, and they may be noted in CHD, the cauda equina syndrome and degenerative changes in the spine, such as spondyloarthrosis. The hip joint is actively extended during the stand test. Dogs with affected joints respond differently to the degree of inflammation and fibrosis of the articular capsule. Young dogs with strained articular capsules and mild inflammatory changes may respond similarly to healthy dogs (17). The above explains a high percentage of negative test results both before (82%) and after (90%) surgery.

ART results are not fully representative of CHD, either. Positive results may be noted in dogs affected by inflammation of the spinal cord in the lumbar spine and disc dislocation in the L-S1 disc space. A positive result suggests inflammatory changes in the upper section of the articular capsule, which may accompany CHD (18). The applied treatment significantly modified the percentage of dogs showing negative ART results from 1% before surgery to 54% after surgery.

HET is an equally non-specific test. Positive results are reported not only in articular capsule inflammation caused by CHD, but also in the contracture/inflammation of the iliopsoas and the cauda equina syndrome. The capsule surrounding the femoral neck becomes tense during the test. HET is not a quantitative test, it points to the presence of inflammation without evaluating its extensiveness. This test has a similar diagnostic value to ST (17). The results of the experiment indicate a significant change in the percentage of dogs with negative HET results after treatment – from 18% before surgery to 45% after surgery.

DLST is a specific pain test for CHD. A positive result is noted in inflammation of the dorsal part of the articular capsule. Positive DLST results are independent of concurrent spinal disease. It is indicative of articular capsule tension, which accompanies CHD. As observed by Walker et al. (19) and Slocum et al. (17, 18), the above relates to recurring subluxation of the hip joint. Zhang et al. (20) demonstrated that positive DLST results are very highly correlated with distraction index values. The above was validated by genetic research of dogs affected by CHD. In the presented experiment, DLST results revealed the greatest change in the percentage of dogs responding negatively after surgery – from 0% before surgery to 73% after surgery.

Positive BS results are relatively non-specific for CHD. They point to articular capsule straining due to subluxation that accompanies dysplasia (17). The change in the percentage of dogs showing a negative response was insignificant, and the difference before and after surgery reached 9%. Similar results were noted in OS, where the percentage of dogs producing a negative response after treatment increased by 9%. OS is also a relatively non-specific test for CHD. It points to articular capsule straining, which often accompanies dysplasia. OS results have little value for OA diagnosis (6).

AF values measured before and after treatment showed a significant deterioration in the flexion contracture of the hip joint. AE measurements indicate

### Table 6

Angle of inclination (AI) determined after CO and IO

<table>
<thead>
<tr>
<th>group</th>
<th>°AI</th>
<th>n</th>
<th>a</th>
</tr>
</thead>
<tbody>
<tr>
<td>F</td>
<td>147-150</td>
<td>5</td>
<td>good</td>
</tr>
<tr>
<td>G</td>
<td>135-147</td>
<td>6</td>
<td>very good</td>
</tr>
</tbody>
</table>

x° - angle, n – number of dogs, a – owners' opinion about limb functionality before treatment.

![Fig. 3. AI values (%) in experimental groups after CO and IO.](image)

![Fig. 4. X-ray performed 12 months after surgery.](image)

**Discussion**

A 20-min-long assessment of the animals' movement at walk and trot showed that in the reference period (12 months), 55% of patients were affected by the first degree and 45% by zero degree lameness on Millis five-point grading scale (11). The owners evaluated the functionality of the operated limbs (mobility, absence of pain) as good and very good. All dogs were mobile despite an absence of surface area congruence shown in radiological examinations. Radiological changes were not correlated with an improvement in the dogs' condition or the disappearance of lameness. Similar observations were made by Braden et al. (3). Diagnostic tests have little value in the correct identification of hip dysplasia due to the relatively non-pathognomonic character of positive results. Nevertheless, the positive results produced by several clinical tests support suspicions of CHD (17), as demonstrated in this study.
that surgery extended the range of motion of the hip joint by 18% in the investigated animals. This improvement can most likely be attributed to the reconstruction of the acetabular roof. Similar observations were made by Bitan et al. (2).

AB values approximating the correct values were noted in 27% dogs before surgery and in 37% after treatment. As regards the AD values, the applied treatment increased the percentage of dogs showing nearly correct values by 27%.

AI measurements before surgery indicated that all of the treated animals were affected by the valgisation of the femoral neck (8). Dogs, whose overall condition and movement were described as "very bad" by the owners, showed AI values in the range of 160° to 162°, while animals in the "bad" category produced AI values from 155° to 158°.

To centralise the femoral head and position it deeper in the acetabular space, AI was modified intraoperatively to 135°C by inducing the coxa vara position in six cases (group F) and to 147°-150° in five cases (group G). The correct AI values for medium-sized breeds are in the range of 145°-147° (8, 13). According to the owners of group F dogs, the condition of the operated limb was "very good", and group G dogs were "good". The above results are consistent with Walker's (19) observations relating to changes in the AI values of the femoral neck induced by the OI method in CHD patients. The case of a dog, whose radiological images are presented in Fig. 4, shows the left hip joint on the operated side with clear acetabulum reconstruction and an inflamed right joint with degenerative changes and signs of bone lysis. The hip joint on the operated side was not a source of pain, and the animal shifted its body weight to the operated side.

DLST was most correlated with the results of surgery. Negative DLST results increased by 73% after CO and IO procedures. Negative ART results increased by 53%, and HET results – by 27%. The usefulness of AE, AD, and AB values in evaluating the functionality of the operated limb has not been fully validated by the findings of this experiment. The reported results are not highly reliable owing to a small number of examined animals. Only AI values were highly representative of postoperative results and were highly correlated with an improvement in the functioning of the treated limb. Treatment results reported after simultaneous CO and IO are more satisfactory than the outcomes of a conventional OI procedure alone (3), and they resemble the results of triple pelvic ostectomy (16).

Eleven surgeries do not provide sufficient material for verifying the effectiveness of the described method and the diagnostic value of the examined parameters. Nevertheless, the noted results seem promising and they justify the need for further research with the involvement of a larger animal population.

References


