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CONTINUING EDUCATION

ORTHOPEDICS

Hip Dysplasia: Navigating Surgical Options and Timing

Clara S. S. Goh, *BVsc, MS, DACVS-SA, ACVS Founding Fellow—Surgical Oncology*
Colorado State University College of Veterinary Medicine and Biomedical Sciences

Veterinary practitioners are familiar with the pain and disability associated with hip laxity and subsequent osteoarthritis in juvenile and mature phase canine hip dysplasia (HD). Several surgical options can be used with medical therapies to optimize comfort and function for these patients, but ideal timing and optimal stage of HD for the various procedures can be confusing to navigate.

When trying to compare surgeries in terms of outcome, you will find that the veterinary literature is lacking in long-term, high-quality, peer-reviewed studies. A systematic review found inadequate evidence to support the claim of full return to normal function with any HD surgical procedure due to lack of longer-term outcome measures or low case numbers.[1] Nonetheless, surgical indications specific for each HD surgery can optimize success for the patient. This article highlights key clinical and diagnostic features that may aid in patient selection and treatment decision-making.

JUVENILE PUBIC SYMPHYSIODESIS

Juvenile pubic symphysiodesis (JPS) uses electrosurgery (most commonly) or staples to arrest ongoing endochondral bone growth at the pubic symphysis. Due to the anatomic location of this symphysis ventral to the acetabula, as the remaining pelvis continues to grow there is progressive ventroversion of the acetabula. This increased dorsal acetabular coverage of the femoral heads is thought to decrease subluxation, restore or improve hip biomechanics, and ideally normalize ongoing hip conformation and function as the dog reaches skeletal maturity.

Timing

The degree of acetabular ventroversion achieved predictably correlates to the age at which JPS is performed. As 80% of pelvic growth is complete by 17 weeks of age,[2] JPS must be performed early to be effective. Dueland et al pioneered canine JPS in 2001 and initially defined electrocautery dosages and optimal timing of the

CONSIDER THE OPTIONS
There are several clinical and diagnostic features to consider when selecting a surgical option for canine hip dysplasia.

technique.[3-5] The ideal age for JPS is between 12 and 18 weeks of age,[3,6-8] although the author recommends JPS prior to 16 weeks for a more predictable outcome in most patients. The window of opportunity may be wider for giant breeds and has been described up to 22 weeks.[7,8]

Case Selection

Severity of hip dysplasia also factors into success and patient selection for JPS. Clinical measures of hip pain and lameness are variable and difficult to objectively assess in JPS candidates. In some studies, most JPS patients (85%) had no evidence of hip pain on preoperative evaluation[3,8] and mixed presence of hip pain at a 2-year follow-up.[9] Force plate gait analysis comparing JPS and control dogs at 1 or 2 years of age showed normal results for both groups.[3,5]

Distraction index (DI) measured on PennHIP radiographic studies (**BOX 1**) is a commonly used measure of hip laxity and predictor of hip degenerative joint disease (DJD).[10] JPS has been found to be most effective at restoring normal hip congruity in puppies with a preoperative DI of 0.4 to 0.6 (and best with a DI <0.5).[7,11] When puppies started with a DI greater than 0.6, moderate to severe degenerative changes in the hips were likely to progress with maturity.[7,9,11] Clinically, DI has been recommended as a predictor of future DJD for dogs older than 16 weeks.[10] As JPS seems most effective when performed earlier (12 to 16 weeks) an unofficial PennHIP report with DI can be

BOX 1 PennHIP Study*

This radiographic study is performed by certified examiners with the patient under heavy sedation or anesthesia. Prior manipulation of the hips should be avoided as cavitation (nitrogen bubbles in the joint) can result, which precludes accurate interpretation of images. Three radiographic projections are obtained.

Hip extended ventrodorsal pelvis (**FIGURE A**). This view is the same as that obtained for Orthopedic Foundation for Animals hip certification and is used to evaluate the joints for evidence of osteoarthritis.

Distraction view (**FIGURE B**). A standard fulcrum device is used between the proximal femurs to obtain this radiograph. This allows calculation of the distraction index (DI). A DI of 0 equals no subluxation; 1 indicates a fully luxated joint.

Compression view (**FIGURE C**). This view is best for evaluating joint congruency, as inability to fully compress the joints and achieve complete congruity may indicate early joint remodeling.

**For positioning best practices for PennHIP radiographs, visit antechimagingservices.com/antechweb/about-ais-pennhip-online-training*

obtained prior to 16 weeks for JPS decision-making. In such cases, the patient's data will not be included in the wider canine PennHIP database and may not be reflective of true hip laxity later in life.[12]

The orthopedic examination finding of Ortolani sign (**BOX 2**), which is palpable reduction and subluxation of the hip, can be correlated with severity of hip dysplasia and DI.[13] Measured angle of reduction (AR) and angle of subluxation (AS) may be helpful to identify dogs that will benefit from JPS: AR between 15° and 25° is considered mild, between 26° and 35° moderate, and greater than 36° severe HD.[7] Ortolani sign seems to disappear in at least half of JPS-treated versus conservatively managed dogs.[3,5,14] A trend of decrease in AR from a preoperative mean angle of 32° to 34° to a 2-year mean angle of 4° to 6° has also been reported, compared with no significant angle change in control hips.[3,5,9]

In summary, JPS is best considered in puppies with mild to moderate hip dysplasia between 12 and 18 weeks of age (potentially up to 22 weeks in giant breeds). At-risk breeds or relatives known to have hip dysplasia should be screened for positive Ortolani sign between 12 and 16 weeks, and further evaluation with PennHIP radiographs should be considered to better determine ideal candidacy. It is important to note that many puppies may not show any clinical signs, and JPS may thus be considered a preemptive rather than a therapeutic intervention.

BOX 2 Ortolani Sign

This procedure is best performed with the patient under sedation or general anesthesia.

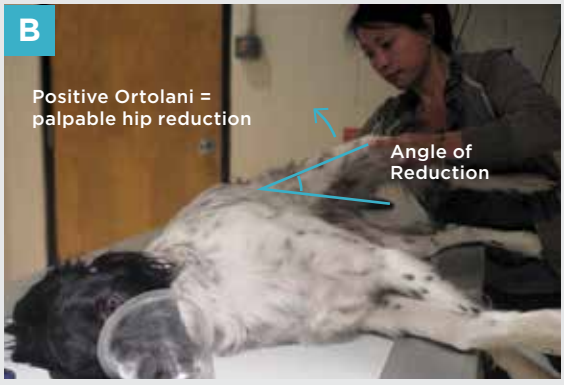
Step 1. Positioning (**FIGURE A**). The patient is in lateral recumbency. The examiner has 1 hand supporting the dorsal pelvis with their thumb over the greater trochanter and the distal hand over the stifle holding the femur parallel to the table.

Step 2. Hip subluxation (**FIGURE A**). Proximal pressure is applied through the femur causing dorsal subluxation if laxity is present. Note: this subluxation may not be palpable at this time.

Step 3. Hip reduction (**FIGURE B**). The femur is slowly abducted **(blue arrow)**. A palpable reduction of the hip indicates hip reduction and a positive Ortolani sign. The angle of abduction from parallel to the table is the angle of reduction (AR).

Step 4. Hip subluxation (**FIGURE C**). If a positive Ortolani sign was detected, the limb is slowly adducted **(blue arrow)**. A more subtle subluxation of the hip may be palpated. The angle of subluxation from parallel to the table is the angle of subluxation (AS).

The maneuver should be repeated several times, especially if AR and AS are measured, and an average of measurements recorded.



TRIPLE OR DOUBLE PELVIC OSTEOTOMY

Pelvic osteotomy procedures were first described in 1969 with the mechanical objectives of increasing dorsal acetabular coverage of the femoral head, decreasing hip laxity and subluxation, and improving joint congruency and articular cartilage loading.[15,16] In clinically affected patients, the aim is to improve function and lameness and limit progression of osteoarthritis (OA).[16,17] When performed in subclinical young patients before the presence of OA, the goal is to restore normal joint mechanics and prevent the onset or progression of OA.[16]

The triple pelvic osteotomy (TPO) involves osteotomies in the ilium, pubis, and ischium. The ilium is then typically stabilized with a bone plate and screws prefabricated with 20° to 40° of rotation, which determines the acetabular ventroversion.[16,18] The more recently introduced double pelvic osteotomy (DPO) avoids the ischial osteotomy and has been proposed to improve immediate postoperative stability with reduced implant loosening and fewer complications,[17] although these benefits may be attributed to newer locking implants.[19] Leaving the ischium intact can make it more difficult to achieve acetabular ventroversion (roughly 5° less than TPO)[20] and may be reserved for younger patients with more malleable bone or cases where bilateral simultaneous surgery is performed.

Timing

Identification of the ideal TPO or DPO patient is challenging, as the perfect candidate has significant hip laxity but possesses good bone conformation without secondary remodeling or OA. Thus, similar to JPS, many ideal candidates have minimal or absent clinical signs during the stage at which the procedure is ideally performed.

The choice to perform surgery in the absence of lameness and related clinical signs directly correlates with how proactive the client and surgeon wish to be. If the goal is to optimize hip function and minimize progression or formation of OA, surgery may be a reasonable consideration. If performance goals are less lofty, a more conservative approach may be to see how clinical disease manifests for the patient as it moves out of the juvenile and into the mature phase of disease and consider treatment (surgical or nonsurgical, as indicated) in the future. Conversely, in the lame or clinically affected HD patient, surgical indications depend on ruling out poor bone conformation, secondary remodeling, or significant OA to ensure a successful outcome.

The most common signalment for TPO/DPO patients is a large- or giant-breed dog between 5 and 12 months of age. This reflects the fact that older HD patients frequently manifest bone remodeling and OA once they reach skeletal maturity rather than at a specific age. Although larger breeds tend to be overrepresented in the literature, successful outcomes have been reported in smaller breeds following TPO.[21]

Case Selection

Early detection and quantification of hip laxity is a key factor in patient selection. A positive Ortolani sign is most useful in characterizing degree of laxity and may also be used to gain early insight into hip conformation. Palpation of crepitus and indistinct reduction during Ortolani testing have been suggested to correlate with wear, remodeling, and formation of OA of the dorsal acetabulum,[22] although this is a very subjective assessment.[23] Measured AS and AR have been used as guidelines to estimate the degree of acetabular ventroversion necessary to prevent subluxation of the femoral head.[17,18] If measured angles are high (>36°), it is unlikely that TPO/DPO will successfully prevent ongoing hip subluxation. Some surgeons use AS plus 5° as the ideal degree of acetabular ventroversion during surgery.[17] Although most useful for subjective hip assessment, true correlation of Ortolani sign with degree of ventroversion and postoperative outcomes is unfortunately lacking; thus, this sign is often the first step in initiating more objective testing.[23]

Various pelvic radiographic studies have been used to measure hip laxity, assess joint congruency, and detect secondary remodeling and OA. The PennHIP series is perhaps the most comprehensive in providing predictive insight into likelihood of future development of OA based on DI and breed statistics. It also includes hip extended and compression ventrodorsal pelvic views that are most useful in assessment of secondary remodeling and OA, as well as joint congruency.[24,25] If any radiographic signs of OA are present, progression of OA is likely and may preclude surgical candidacy. Assessment of the dorsal acetabular labrum, critical to the success of the surgery, is more challenging. The dorsal acetabular rim view has been historically used for this purpose,[26] although availability and ease of

computed tomography (CT) in more recent times have decreased popularity of this radiographic study.[6,27]

Absence of radiographic signs of hip OA is unfortunately not sensitive for ruling out articular cartilage damage.[28] Although CT has been found to be a superior assessment tool to radiography,[29] some surgeons recommend hip arthroscopy to confirm cartilage health prior to TPO/DPO.[28]

TOTAL HIP REPLACEMENT

Canine total hip replacement (THR) has been performed since the 1970s. The original Richards implants consisted of cemented, fixed-head systems with stainless steel femoral stems and polyethylene acetabular components.[30] In 1990, BioMedtrix introduced the modular cemented THR system (CFX), which allowed more customization of implants to the individual patient.[31] The main advantage of CFX prostheses is immediate postoperative stabilization of the implants within bone, with rapid patient recovery and resolution of clinical signs.[30] Unfortunately, aseptic implant loosening became a commonly recognized complication in CFX patients due to failure of the cement mantle at the bone–cement or cement–implant interface.[32]

In 2003, the cementless BioMedtrix BFX THR system was released, and the CFX and BFX THR systems were combined to form the interchangeable Universal THR system in 2007. The other most widely used cementless THR system (Zurich; Kyon, kyon.ch) was released in the late 1990s.[33] Currently, most canine THRs are cementless. Cementless THR systems achieve short-term stability via press-fit, locking screw fixation, or screw-in implants and long-term stability via bone ingrowth into implants.[34] BioMedtrix and Kyon THR systems continue to evolve over time with changes made to implant design, materials, surface coatings, and customization of various components in efforts to reduce incidence of implant loosening, wear debris, and fatigue failure and to improve biocompatibility.[34]

Timing

Many surgeons feel that THR provides the best functional outcome for HD dogs with clinically significant OA, with an overall average cited success rate of 90% to 95%.[34] Reported complication rates are highly variable (5% to 22%) and most studies report similarly variable revision rates, making use of this information for surgical comparison challenging. This variability is likely related to differences in the implant system used, generation of the implant system, surgical technique, length of follow-up, and surgeon experience.[34]

THR surgery is typically recommended when pain and loss of function become refractory to medical management, weight control, and physical therapy. Most surgeons prefer patients to be skeletally mature; however, early surgery may be recommended if severe subluxation of the hips is present, which can increase incidence of postoperative implant luxation.[34] Successful THR with the BFX system has been described in juvenile dogs aged 6 to 10 months.[35] The reported age range for use of the Zurich THR is 4.5 months to 12.6 years, with some risk factors related to undersized implants and significant acetabular cup wearing identified in the younger patient group.[33,36,37]

Case Selection

Patient size for THR was originally limited to dogs weighing more than 15 to 20 kg to accommodate the standard prostheses. Introduction of the BioMedtrix Micro and Nano cemented THR systems in 2005 and 2010, and the more recent release of sixth-generation Zurich cementless mini THR sizes, now allows implantation of THR systems in patients as small as 2 kg. Although less widely available and with more limited published data to date, the Micro and Nano THR systems appear to have a similar success and slightly higher complication rate compared with their standard CFX counterparts.[38-40] The higher complication rate is likely related to the learning curve with these relatively new systems.

Thorough patient screening for concurrent orthopedic or neurologic disease is recommended, especially if deterioration of clinical signs has been acute. In one study, 32% of dogs presented for HD had lameness attributable to cranial cruciate ligament disease.[41] Concurrent lumbosacral disease and HD is also not an uncommon clinical finding. Management of these concurrent conditions is typically recommended before reevaluation for THR candidacy.[34]

FEMORAL HEAD AND NECK OSTECTOMY

Femoral head and neck ostectomy (FHO) is performed for a variety of conditions and trauma affecting the hip

Although the most common FHO technique is via a craniolateral approach, the author's preference is to perform FHO via a ventral approach to the hip.[42,43]

joint, including advanced HD. Surgical removal of the femoral head and neck eliminates pain related to irregular bone-on-bone contact in the degenerative joint and allows formation of a pseudarthrosis made up of dense fibrous tissue.[34]

Although the most common FHO technique is via a craniolateral approach, the author's preference is to perform FHO via a ventral approach to the hip.[42,43] Clinical outcome studies on the technique are lacking, but perceived benefits include sparing the gluteal muscles and dorsal joint capsule, which may improve stability and allow a faster return to limb function postoperatively.

Timing

Frequently referred to as a "salvage" procedure, the FHO is often the default procedure for HD patients that are not good candidates for other juvenile surgical options or THR and have failed medical management. The author does not agree with considering FHO only as a "last resort," as this may encourage waiting until the patient has significant muscle atrophy and obesity, making postoperative rehabilitation and recovery less successful. Instead, the surgical indications for FHO are very similar to those for THR. The main difference is in a skeletally immature patient, for which there is little detriment in waiting to see how the HD clinically manifests before performing FHO. Exceptions for earlier FHO may be considered for patients with very severe HD with complete femoral head subluxation refractory to medical management.

Case Selection

Historically, outcomes for patients weighing more than 20 kg were considered inconsistent and FHO was therefore not previously recommended for larger breeds.[44,45] More recent literature has reported similar outcomes regardless of patient size,[46] although larger patients with higher athletic goals likely require more dedicated postoperative rehabilitation. Owner-assessed satisfaction with FHO is routinely high (>90%) despite limb dysfunction assessed by clinical and objective measures as only satisfactory (20%) and unsatisfactory (42%) in a significant portion of the same patient population.[46] This discrepancy is likely due to the functional limb shortening and loss of normal joint kinematics caused by the pseudarthrosis, which are observable on gait and kinetic assessment but in most cases do not appear to elicit a pain response with manipulation of the limb.[46]

Ultimately, when helping a client decide between THR and FHO surgery, the main considerations include financial constraints, athletic goals, initial postoperative considerations (more activity restriction for THR, fewer restrictions but more intense rehabilitation for FHO), and client acceptance of possible complications (higher risk for THR than FHO). Although surgical revision of poor responders to FHO with THR has been reported, this practice is not recommended due to higher risk of subsequent THR complications such as challenging intraoperative implant positioning and reduction, as well as increased postoperative implant luxation. TVP

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Clara S. S. Goh

Dr. Goh earned her BVSc degree from the University of Sydney and her MS from Colorado State University, where she also completed her fellowship in surgical oncology and is currently an assistant professor in small animal orthopedic surgery. She is a frequent speaker at international conferences and a member of *Today's Veterinary Practice*'s Editorial Advisory Board.

CONTINUING EDUCATION

Hip Dysplasia: Navigating Surgical Options and Timing

TOPIC OVERVIEW

This article provides an overview of the main surgeries performed for juvenile and mature phase hip dysplasia in dogs. Clinical features and key diagnostic orthopedic examination and radiographic findings that aid in optimal patient selection are highlighted.

LEARNING OBJECTIVES

After completing this article, readers should be able to identify key clinical indications and contraindications for common hip dysplasia surgeries and recognize useful diagnostic tests that may aid in ideal case selection.

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1. **Arrest of ongoing growth from the _____ symphysis during JPS surgery results in bilateral acetabular ventroversion due to its anatomic location.**
   a. Pelvic
   b. Pubic
   c. Acetabular
   d. Ischial

2. **When purely considering age, the ideal timeframe for JPS surgery is:**
   a. 8 to 14 weeks
   b. 12 to 18 weeks
   c. 16 to 22 weeks
   d. 20 to 26 weeks

3. **On PennHIP radiographic studies, the distraction index (DI) correlates to severity of hip laxity and can predict future likelihood of OA development. For JPS and TPO surgeries, the ideal candidate's DI is:**
   a. 0 to 0.2
   b. 0.2 to 0.5
   c. 0.5 to 0.7
   d. 0.7 to 1

4. **Which of the following is a common clinical feature(s) of the ideal JPS candidate?**
   a. Obvious bilateral hind-limb lameness on gait analysis
   b. Significant hindquarter muscle atrophy and crepitus on hip manipulation
   c. Negative Ortolani sign
   d. Discomfort on hip extension and positive Ortolani sign

5. **The orthopedic examination finding of a positive Ortolani sign is most useful as part of the diagnostic work-up for which surgery/surgeries?**
   a. JPS
   b. TPO
   c. DPO
   d. All of the above

6. **Osteotomy of which bone is performed in a TPO but not a DPO?**
   a. Ilium
   b. Pubis
   c. Ischium
   d. Acetabulum

7. **What clinical/diagnostic finding(s) may preclude a patient's ideal candidacy for TPO/DPO surgery?**
   a. Significant hip remodeling and osteoarthritis on radiographs
   b. Palpable subluxation and reduction of the hips when ambulating
   c. Indistinct positive Ortolani sign with palpable hip crepitus on manipulation
   d. a and c

8. **What clinical/diagnostic feature(s) may preclude a patient's ideal candidacy for THR surgery?**
   a. Significant hip remodeling and osteoarthritis on radiographs
   b. Severe chronic (>2 years) complete hip subluxation on radiographs
   c. Concurrent cranial cruciate ligament disease
   d. b and c

9. **What should be discussed with owners before FHO in patients weighing more than 20 kg?**
   a. Dedicated postoperative rehabilitation will be essential
   b. FHO will not provide a comfortable functional outcome
   c. FHO should only be considered as a "last resort"
   d. Surgery should be performed prior to skeletal maturity

10. **What factor(s) is/are likely to affect success of FHO surgery?**
    a. Dedicated postoperative rehabilitation
    b. Surgical timing
    c. Surgical approach
    d. All of the above