Reminder of important clinical lesson

Osteonecrosis and femoro-acetabular impingement: sequelae of developmental dysplasia of the hip

Jason Pui Yin Cheung,¹ Wang Chow,² Michael To²

¹Department of Orthopaedics and Traumatology, Queen Mary Hospital, Hong Kong, Hong Kong;

²Department of Orthopaedics and Traumatology, The Duchess of Kent Children's Hospital, Hong Kong, Hong Kong

Correspondence to Dr Michael To, mikedtto@hku.hk

Summary

A 2-year-old girl with developmental dysplasia of the right hip underwent open reduction and capsulorrhaphy via the anterior approach with hip spica casting in an internally rotated position. During her 26 years of follow-up, she was found to have osteonecrosis and subsequently cam-type femoro-acetabular impingement at 28 years of age. She was treated with surgical dislocation of the hip and osteochondroplasty to recreate the normal contour of the head and neck offset.

BACKGROUND

Osteonecrosis (ON) after treatment for developmental dysplasia of the hip (DDH) is a known complication with a reported incidence of 0–73%.^{1–7} However, the usual time frame leading to its appearance and other long-term complications such as degeneration and femoro-acetabular impingement (FAI) is unknown. This is a 26 year follow-up of a patient with developmental DDH highlighting the importance of identifying associated sequelae of ON and FAI during regular follow-up. In addition, the management of the dislocated hip during the initial presentation in the patient could have precipitated the following events. The management of DDH still encompasses many controversial issues and this report would further discuss these disputes.

CASE PRESENTATION

A 2-year-old girl first presented to our orthopaedic unit for developmental dysplasia of the right hip. She was the first born child and was born full-term by spontaneous vaginal delivery. For her antenatal history, she was in normal lie and there was no oligohydramnios. There was also no positive family history of developmental DDH. She had limping gait and limb shortening of 1 cm at the left hip. Her hip abduction range of motion reduced to 45 degrees on the left side as compared to 70 degrees on the right. Galeazzi sign was also positive.

INVESTIGATIONS

Roentgenogram (figure 1) showed obvious dislocation of the left hip by the position of the metaphyseal beak. The

Figure 1 Preoperative radiograph of the pelvis (anteroposterior) showing dysplasia of the hip of the left hip.

Figure 2 Postoperative radiograph of the pelvis (anteroposterior) with the left hip reduced but the hip was placed in an internally rotated position within the hip spica cast.

Figure 3 Pelvis (anteroposterior) radiograph at 2.5 years old showing irregular capital femoral epiphysis signifying osteonecrosis.

Shenton's line was broken on the left and the medial space was widened on the left by 6.5mm as compared with the right. The acetabulum was dysplastic as indicated by the absence of the sourcil and the steeper acetabular index of Tonnis^{8,9} on the left side (41 degrees) as compared with the right (16 degrees).

TREATMENT

She was treated with traction but was unable to tolerate it. Open reduction and capsulorrhaphy via the anterior approach was performed and she was immobilised in a hip spica cast (figure 2) with the left hip in 30 degrees of abduction, flexion and internal rotation.

OUTCOME AND FOLLOW-UP

The hip spica was removed after 1.5 months of use. At 5 months after the open reduction (2.5 years old), she was able to walk normally with a range of motion comparable to the normal side. Radiograph (figure 3) showed that the hip was well reduced and the acetabulum was remodelling (acetabular index of 33.3 degrees). There were also signs of ON (Buckholz and Ogden¹ grade 1) with proximal femoral epiphysis growth disturbance. At 7 years old, radiograph (figure 4) showed deformities of coxa magna, coxa brevia and coxa plana. The acetabulum was well remodelled to an acetabular index of 24.1 degrees.

She was well all along until 28 years of age when she presented with increasing left groin pain when squatting or fully flexing her hip. There were no problems during climbing stairs or sitting. Clinically, she had no limp or trendelenburg gait. The range of motion of the both hips was comparable but the impingement sign (pain on hip flexion and internal rotation) was positive for the left hip. Radiograph (figures 5 and 6) showed loss of sphericity of

Figure 4 Pelvis (anteroposterior) radiograph at 7 years old showing altered morphology of the femoral head with coxa magna, coxa brevia and coxa plana. Acetabulum had remodelled satisfactorily.

the left femoral head with uncoverage likely due to the coxa magna deformity and also a bump and herniation pit indicating a cam type femoral-acetabular impingement.^{10–12} In the false-profile view, the hip joint had no anterior coverage problem. The anterior offset^{10–12} was 3.67 mm on the left side (normal >7 mm) and the anterior offset ratio^{10–12} was 0.09 (normal 0.18–0.2). CT showed that the acetabulum was in 27 degrees anteversion. MRI was also performed which showed an α angle^{10–12} of 69 degrees (normal 50–55 degrees) and also an anterior-superior labral tear.

Surgical dislocation of the left hip with osteochondroplasty was performed. Intraoperatively, dysplastic or early degenerative changes of the femoral head with resultant asphericity were found (figure 7). During hip flexion and internal rotation, the bump over the femoral head-neck junction would impinge on the anterior-superior aspect of the acetabulum which was where the labral tear was found. The normal morphology of the femoral head and neck junction was retained after the osteochondroplasty (figure 8) and there was no more impingement on the acetabulum. The impingement sign was negative after the operation and the patient obtained pain-free ambulation. Postoperative radiograph showed the recreation of the femoral head and neck junction contour (figures 9 and 10).

DISCUSSION

The principle of management of DDH is to obtain concentric reduction of the dislocated hip allowing normal acetabular development. This is to avoid residual acetabular dysplasia which leads to premature osteoarthritis and also secondary reconstructive procedures. Concentric reduction should also be obtained at an early age as the potential of the acetabulum to remodel is maximal in the first year of life and rapidly declines after 18 months.¹³

Figure 5 Pelvis (anteroposterior) radiograph at 28 years old showing cam type femoro-acetabular impingement with lateral uncoverage of the femoral head due to coxa magna deformity. A bump and herniation pit was seen over the femoral head and neck junction.

Figure 6 Frog-lateral radiograph of both hips at 28 years old showing asphericity of the left femoral head with reduced anterior offset and anterior offset ratio.

Furthermore, the window period for acetabular remodeling closes at 8 years of age.¹⁴ A study by Lindstrom *et al* showed that with 185 dislocated hips successfully treated with closed reduction, those patients with reduction performed less than 1 year old had the lowest final acetabular index while those with reduction performed later than 2 years of age had the highest final acetabular index.¹⁵ In terms of open reduction, Roose *et al* showed that using the medial (Ferguson) approach, patients with reduction done at an average of 7.2 months old required no secondary acetabular procedure and patients with reduction at 16 months old requires a secondary Salter osteotomy or femoral varus osteotomy.¹⁶ Another study by Luhmann *et al* showed that in 153 hips treated with open reduction via the anterior approach, 17% of patients who were treated at less than 6 months of age required a reconstructive procedure and 74% of patients who were treated at an age of more than 18 months required a secondary reconstructive procedure.¹⁴ Thus, there is significant evidence in the literature supporting early reduction in DDH.

Besides obtaining early concentric reduction, the method of treatment also has bearing upon the future congruity of the hip joint. There are risks involved with each stage of treatment that could lead to ON and subsequently early osteoarthritis as well. Proposed ischaemic

Figure 7 Intraoperative photo after the surgical hip dislocation showing the loss of smooth contour of the left femoral head.

mechanisms include extrinsic blood vessel compression and excessive pressure on the femoral head. Prereduction traction had been shown to gently stretch the soft tissue around the hip joint which reduced growth disturbances of proximal femoral epiphysis and improved the success rate of closed reduction up to 91%.^{3 7 17} Obtaining a traction station of plus-2 would have the most significant reduction in the ON risk.² The role of traction has diminished in current practice as this method of treatment is mainly conventional wisdom and has fallen out of favour. There are questionable benefits and there is no significant influence on intra or extraarticular obstacles to reduction. In terms of the method of reduction, the risk of ON was reduced by 99% (OR 0.01) in closed reduction as compared with open reduction. Moreover, open reduction alone reduced ON by 89% (OR 0.12) versus open reduction and a pelvic or femoral osteotomy.⁵ A femoral varus osteotomy and femur shortening could reduce the risk of ON.¹⁸ In a biomechanical study, 30 degrees of varus osteotomy reduced 70% of the stress load through the femoral head.¹⁹ There is no strict guideline on when a femoral procedure should be done. Rather the decision is usually an intraoperative decision by the operating surgeon when the hip requires a lot of force to reduce or if there is increased soft tissue tension after reduction. There were no studies directly comparing the risk of ON with the medial or anterior approach and the quoted risk of ON in open reduction was quite variable (0–67%).^{20 21} The position of immobilisation is also important. Although there are no guidelines on the optimal position, there were studies documenting a high

Figure 8 Intraoperative photograph of the left hip joint after osteochondroplasty showing the reformed head and neck junction.

risk of ON with hip spica immobilisation in wide abduction and internal rotation.^{22 23} In this position, there is constriction of the posterior feeding vessels to the femoral head leading to ON.

The treatment of DDH is not without controversy. There were many physicians who routinely delay any manipulation until the capital femoral epiphysis is ossified due to the suggested vulnerability of preosseous capital femoral epiphysis to compressive ischaemic injury.⁶ The role of the ossific nucleus was believed to reduce 54% of the compression strain across the region of the posterosuperior branch of the medial circumflex artery when the ossific nucleus occupied 40% of epiphysial volume in favor of delayed reduction.⁶ A study by Segal *et al* showed an ON rate of 4% with the presence of ossific nucleus before reduction and an ON rate of 53% without the ossific nucleus.⁶ In contrast, Luhmann *et al* showed that the rate of ON was similar with or without the presence of ossific nucleus.¹⁴ A metaanalysis of six studies also showed no significant difference in the rate of ON in patients with ossific nucleus (19%) or without (22%).²⁴ However, in the subgroup analysis of this study, in patients with closed reduction performed, the presence of ossific nucleus reduced the probability of ON by 60%.²⁴ Thus, although the protective effect of the ossific nucleus is still under debate, there is no clear benefit of the presence of the ossific nucleus in preventing ON.

In addition to ON, FAI is possible sequelae of DDH with an overall reported prevalence of 20–79%.^{25 26} It is however, unknown how often DDH develops into FAI. One

Figure 9 Postoperative anteroposterior radiograph showing better coverage of more spherical femoral head at the left hip.

Figure 10 Postoperative frog-lateral radiograph showing the reformed left femoral head and neck junction offset.

study reported a 47% of patients with symptomatic FAI having radiographic evidence of dysplasia.²⁷ FAI is commonly associated with labral tears and is usually found at the anterosuperior aspect where the cam-type FAI usually articulates with during movement. These tears are usually diagnosed on preoperative MRI and arthrograms can be used to increase its sensitivity. Other associated lesions seen on the MRI include para-labral cysts and cartilage delamination. The presence of FAI is a poor prognostic factor as up to one-third of patients with FAI progress to osteoarthritis in 10 years.²⁸ Open surgical dislocation with osteoplasty and treatment of labral tear are usually successful in treating FAI with 65–85% of patients satisfied with the management up to 40 months after surgery.²⁹

DDH is a challenging disease entity where a balance is made between concentric reduction and minimising

complications. Early treatment of DDH with concentric reduction can allow for maximal acetabular remodelling potential which can avoid secondary procedures. There is no definite evidence supporting the benefit of ossific nucleus on its effect on ON but long-term sequelae of ON and FAI should be minimised by appropriate treatment. In our patient, her DDH was treated with open reduction without prereduction traction and was immobilised in an internally rotated position. The ossific nucleus was already present and as such this was not a concern related to the development of ON. She was followed-up over a course of 26 years with serial radiographs documenting the change in femoral head morphology and development of FAI secondary to the ON which required surgical treatment.

Learning points

- ▶ DDH should be treated with early reduction.
- ▶ Postoperatively, patients require careful positioning during immobilisation.
- ▶ Certain aspects of DDH management such as open reduction without traction and immobilisation in internal rotation may increase the risk for ON.
- ▶ FAI is a possible outcome of DDH.
- ▶ DDH requires long-term follow-up to identify ON, early degeneration and FAI.

Competing interests None.

Patient consent Obtained.

REFERENCES

1. **Buckholz RW**, Ogden JA. Patterns of ischemic necrosis of the proximal femur in nonoperatively treated congenital hip disease. In: *The Hip: Procs Sixth Open Scientific Meeting of the Hip Society*. St Louis: Mosby 1978.
2. **Gage JR**, Winter RB. Avascular necrosis of the capital femoral epiphysis as a complication of closed reduction of congenital dislocation of the hip. A critical review of twenty years' experience at Gillette Children's Hospital. *J Bone Joint Surg Am* 1972;**54**:373–88.
3. **Kutlu A**, Ayata C, Oğün TC, *et al*. Preliminary traction as a single determinant of avascular necrosis in developmental dislocation of the hip. *J Pediatr Orthop* 2000;**20**:579–84.
4. **Luhmann SJ**, Schoenecker PL, Anderson AM, *et al*. The prognostic importance of the ossific nucleus in the treatment of congenital dysplasia of the hip. *J Bone Joint Surg Am* 1998;**80**:1719–27.
5. **Pospischill R**, Weninger J, Ganger R, *et al*. Does open reduction of the developmental dislocated hip increase the risk of osteonecrosis? *Clin Orthop Relat Res* 2012;**470**:250–60.
6. **Segal LS**, Boal DK, Borthwick L, *et al*. Avascular necrosis after treatment of DDH: the protective influence of the ossific nucleus. *J Pediatr Orthop* 1999;**19**:177–84.
7. **Sibiński M**, Murnaghan C, Synder M. The value of preliminary overhead traction in the closed management of DDH. *Int Orthop* 2006;**30**:268–71.
8. **Tönnis D**. An evaluation of conservative and operative methods in the treatment of congenital hip dislocation. *Clin Orthop Relat Res* 1976;**119**:76–88.
9. **Tönnis D**. Normal values of the hip joint for the evaluation of X-rays in children and adults. *Clin Orthop Relat Res* 1976;**119**:39–47.
10. **Anderson SE**, Siebenrock KA, Tannast M. Femoroacetabular impingement. *Eur J Radiol* 2011 (In Press).
11. **Banerjee P**, McLean CR. Femoroacetabular impingement: a review of diagnosis and management. *Curr Rev Musculoskelet Med* 2011;**4**:23–32.
12. **Peters CL**, Erickson JA. Treatment of femoro-acetabular impingement with surgical dislocation and débridement in young adults. *J Bone Joint Surg Am* 2006;**88**:1735–41.
13. **Salter RB**. The classic. Innominate osteotomy in the treatment of congenital dislocation and subluxation of the hip. by Robert B. Salter, J. Bone Joint Surg. (Brit) 43B:3:518, 1961. *Clin Orthop Relat Res* 1978;**137**:2–14.
14. **Luhmann SJ**, Bassett GS, Gordon JE, *et al*. Reduction of a dislocation of the hip due to developmental dysplasia. Implications for the need for future surgery. *J Bone Joint Surg Am* 2003;**85-A**:239–43.
15. **Lindstrom JR**, Ponseti IV, Wenger DR. Acetabular development after reduction in congenital dislocation of the hip. *J Bone Joint Surg Am* 1979;**61**:112–8.
16. **Roose PE**, Chingren GL, Klaaren HE, *et al*. Open reduction for congenital dislocation of the hip using the Ferguson procedure. A review of twenty-six cases. *J Bone Joint Surg Am* 1979;**61**(6A):915–21.
17. **DeRosa GP**, Feller N. Treatment of congenital dislocation of the hip. Management before walking age. *Clin Orthop Relat Res* 1987;**225**:77–85.
18. **Wenger DR**, Lee CS, Kolman B. Derotational femoral shortening for developmental dislocation of the hip: special indications and results in the child younger than 2 years. *J Pediatr Orthop* 1995;**15**:768–79.
19. **Baker KJ**, Brown TD, Brand RA. A finite-element analysis of the effects of intertrochanteric osteotomy on stresses in femoral head osteonecrosis. *Clin Orthop Relat Res* 1989;**249**:183–98.
20. **Kiely N**, Younis U, Day JB, *et al*. The ferguson medial approach for open reduction of developmental dysplasia of the hip. A clinical and radiological review of 49 hips. *J Bone Joint Surg Br* 2004;**86**:430–3.
21. **Okano K**, Yamada K, Takahashi K, *et al*. Long-term outcome of Ludloff's medial approach for open reduction of developmental dislocation of the hip in relation to the age at operation. *Int Orthop* 2009;**33**:1391–6.
22. **Smith BG**, Millis MB, Hey LA, *et al*. Postreduction computed tomography in developmental dislocation of the hip: part II: predictive value for outcome. *J Pediatr Orthop* 1997;**17**:631–6.
23. **Smith JT**, Matan A, Coleman SS, *et al*. The predictive value of the development of the acetabular teardrop figure in developmental dysplasia of the hip. *J Pediatr Orthop* 1997;**17**:165–9.
24. **Roposch A**, Stöhr KK, Dobson M. The effect of the femoral head ossific nucleus in the treatment of developmental dysplasia of the hip. A meta-analysis. *J Bone Joint Surg Am* 2009;**91**:911–8.
25. **Kappe T**, Kocak T, Bieger R, *et al*. Radiographic risk factors for labral lesions in femoroacetabular impingement. *Clin Orthop Relat Res* 2011;**469**:3241–7.
26. **Yun HH**, Shon WY, Yun JY. Treatment of femoroacetabular impingement with surgical dislocation. *Clin Orthop Surg* 2009;**1**:146–54.
27. **Paliobeis CP**, Villar RN. The prevalence of dysplasia in femoroacetabular impingement. *Hip Int* 2011;**21**:141–5.
28. **Bardakos NV**, Villar RN. Predictors of progression of osteoarthritis in femoroacetabular impingement: a radiological study with a minimum of ten years follow-up. *J Bone Joint Surg Br* 2009;**91**:162–9.
29. **Bedi A**, Chen N, Robertson W, *et al*. The management of labral tears and femoroacetabular impingement of the hip in the young, active patient. *Arthroscopy* 2008;**24**:1135–45.

This pdf has been created automatically from the final edited text and images.

Copyright 2012 BMJ Publishing Group. All rights reserved. For permission to reuse any of this content visit <http://group.bmj.com/group/rights-licensing/permissions>.
BMJ Case Report Fellows may re-use this article for personal use and teaching without any further permission.

Please cite this article as follows (you will need to access the article online to obtain the date of publication).

Cheung JPY, Chow W, To M. Osteonecrosis and femoro-acetabular impingement: sequelae of developmental dysplasia of the hip.
BMJ Case Reports 2012;10.1136/bcr.12.2011.5455, Published XXX

Become a Fellow of BMJ Case Reports today and you can:

- ▶ Submit as many cases as you like
- ▶ Enjoy fast sympathetic peer review and rapid publication of accepted articles
- ▶ Access all the published articles
- ▶ Re-use any of the published material for personal use and teaching without further permission

For information on Institutional Fellowships contact consortiasales@bmjgroup.com

Visit casereports.bmj.com for more articles like this and to become a Fellow

Keep up to date with all published cases by signing up for an alert (all we need is your email address) <http://casereports.bmj.com/cgi/alerts/etoc>