

Dose escalation and proton therapy in chondrosarcoma and chordoma

■ Chondromas and chondrosarcoma are rare malignancies that are challenging to treat, and both surgical and non-surgical treatments form the mainstay of management strategies. Recent studies have suggested that proton beam therapy may be efficacious in treating these lesions, and this retrospective study from **Tampa, Florida (USA)** not only compares the patient outcomes affected by conventional and particle therapy, but also looks at the role of high doses (≥ 70 Gy) of definitive radiotherapy (DRT) and preoperative radiotherapy in both pathologies.⁸ Records from the National Cancer Database collected between 2004 and 2014 were used to identify 863 patients with chondrosarcoma and 715 patients with chordoma who were treated with curative proton beam or conventional radiation therapy, with a dose range between 20 Gy and 80 Gy, and who were followed up for at least 15 months. The authors show that patients receiving DRT were older and showed advanced disease.

For patients with chondrosarcoma, high-dose DRT and proton therapy were associated with improved rates of overall survival at five years. In those patients receiving treatment for chordoma, proton therapy brought improved overall survival at five years, and a high dose of conventional radiotherapy improved overall survival when delivered both definitively and preoperatively. This useful paper shows that high-dose radiotherapy and proton beam therapy may well be useful for chordoma and chondrosarcoma, despite the conventional thinking that these are both radioresistant lesions.

REFERENCES

1. Puri A, Gulia A, Hegde P, Verma V, Rekhi B. Neoadjuvant denosumab: its role and results in operable cases of giant cell tumour of bone. *Bone Joint J* 2019;101-B:170-177.
2. Smeland S, Bielack SS, Whelan J, et al. Survival and prognosis with osteosarcoma: outcomes in more than 2000 patients in the EURAMOS-1 (European and American Osteosarcoma Study) cohort. *Eur J Cancer* 2019;109:36-50.

3. Outani H, Nakamura T, Murata H, et al. Localized synovial sarcoma: a single institutional study of 191 patients with a minimum follow-up of 5 years for survivors. *J Surg Oncol* 2019. (Epub ahead of print) PMID: 30786036.
4. Sugiura H, Tsukushi S, Yoshida M, Nishida Y. What is the success of repeat surgical treatment of a local recurrence after initial wide resection of soft tissue sarcomas? *Clin Orthop Relat Res* 2018;476:1791-1800.
5. Park A, Lans J, Raskin K, et al. Is malnutrition associated with postoperative complications in patients with primary bone sarcomas? *J Surg Oncol* 2019;119:324-328.
6. Laitinen MK, Parry MC, Le Nail LR, et al. Locally recurrent chondrosarcoma of the pelvis and limbs can only be controlled by wide local excision. *Bone Joint J* 2019;101-B:266-271.
7. Kim CY, Collier CD, Liu RW, Getty PJ. Are limb-sparing surgical resections comparable to amputation for patients with pelvic chondrosarcoma? A case-control, propensity score-matched analysis of the national cancer database. *Clin Orthop Relat Res* 2019;477:596-605.
8. Palm RF, Oliver DE, Yang GQ, et al. The role of dose escalation and proton therapy in perioperative or definitive treatment of chondrosarcoma and chordoma: an analysis of the National Cancer Data Base. *Cancer* 2019;125:642-651.

Children's orthopaedics

X-ref For other Roundups in this issue that cross-reference with *Children's orthopaedics* see: *Sports Roundup 2; Wrist & Hand Roundup 1; Oncology Roundup 2.*

Closed reduction for DDH: worth a thought?

■ Developmental dysplasia of the hip (DDH) is one of the leading causes of early osteoarthritis and the subsequent need for hip arthroplasty. A spectrum of disease exists, from mild dysplasia to frank dislocation; the treatment goal is to obtain a concentric and stable reduction to allow normal acetabular growth and remodelling. The driver for DDH also varies considerably with moulding deformities, genetic, and neuromuscular causes. The role of closed reduction (CR) and hip spica casting is being increasingly questioned due to the mixed results following failure of reduction, and the risk of iatrogenic avascular necrosis of the femoral head (AVN). Researchers from the International Hip Dysplasia Institute (IHDI) in **Orlando, Florida (USA)** have, therefore, established and enrolled patients into a multicentre and multinational cohort of patients to examine the long-term outcomes following this procedure, but here they report the short-term results of the study.¹ Data were prospectively collected for patients with

infantile DDH treated between 2010 and 2014. In all, 87 hips in 78 patients were evaluated with a median age at initial reduction of eight months; most also underwent adductor tenotomy at that time. Overall, 79 hips were initially successfully treated with CR and, at the most recent follow-up at a median of 22 months, 72 remained stable giving an overall failure rate of 9%. Likelihood of failure of treatment was not affected by initial reducibility, age at initial CR, or previous brace treatment. More concerning, 25% developed radiological evidence of AVN. Yet, the risk of AVN was unaffected by the presence of an ossific nucleus, by previous brace treatment, age at CR, or pre-reduction reducibility. Duration of brace treatment was, however, predictive of AVN with a mean period of 15 weeks in those who developed AVN versus 12 weeks in those who did not. The acetabular index and IHDI grade were recorded to measure residual dysplasia. The mean acetabular index at latest follow-up was 25° (SD 6°). Indeed, eight of the 72 hips that were initially successfully reduced subsequently closed and were treated for residual dysplasia with femoral and/or acetabular osteotomies. Moreover, an older age at initial CR was predictive of this. Overall, this is a really interesting study that removes a lot of the methodological issues of previous work.

Intermediate to long-term results of femoral neck lengthening (Morscher osteotomy)

■ Coxa brevis or short femoral neck, in association with overgrowth of the greater trochanter, are thought to be caused by an ischaemic event in the proximal femoral epiphysis. This may be caused by a number of pathologies such as Perthes disease, developmental dysplasia of the hip, or following infection. The condition is, in itself, not common, but when it does occur the biomechanical consequences are relatively predictable, with the reduced lever arm causing abductor insufficiency and Trendelenburg gait, as well as a mild leg-length discrepancy and impingement of the trochanters on surrounding structures. Given the mechanical nature of the problem and predictable biomechanical consequences, there ought to be a simple solution with an appropriate osteotomy. In the early 1980s, Morscher developed a femoral neck lengthening osteotomy consisting of a double osteotomy of the shaft and greater trochanter, lateralizing the femur along the line of the neck and restoring the abductor tension. This paper from **Atlit (Israel)** was performed by surgeons in three centres who followed what is probably the largest series of patients treated using this technique.²

Harris Hip Scores, leg-length discrepancy, and satisfaction scores at long-term follow-up were assessed, as well as the proportion of hips undergoing subsequent arthroplasty. Overall, 20 hips in 18 patients underwent treatment with the Morscher osteotomy and were followed up to a median of seven years. The underlying pathology was Perthes disease in ten patients, DDH in four, and avascular necrosis in the other four. The median age at surgery was 16 years and all patients had a limp and Trendelenburg gait. Harris Hip Score improved from 72 preoperatively to 94 postoperatively, leg-length discrepancy was reduced in 17 of the 20 hips and the Trendelenburg test became negative in 14 hips. Three patients had progression of osteoarthritis with one undergoing total hip arthroplasty after four years, and another two patients undergoing arthroplasty after ten years. Patient satisfaction scores were good to excellent in 12 patients, fair in four, and bad in two. There were also implant failures including blade migration in one patient and wire breakage in two patients. There is little evidence regarding long-term prognosis in the literature, and the cohort described are still intermediate term. The surgery is technically challenging and, therefore, should be performed infrequently, but these results give an indication of what is achievable in specialist hands.

Does late hip dysplasia occur after normal ultrasound screening in breech babies? X-ref

Continuing the theme of development dysplasia of the hip (DDH) and screening in this issue of 360, we review another paper on this difficult topic. There is a known association between breech presentation in the later stages of pregnancy and hip dysplasia. In the UK, selective screening is based on risk factors such as family history or breech presentation and ultrasound scanning is considered the benchmark diagnostic screening method for hip dysplasia. This paper from **Southampton (UK)** questions whether a normal ultrasound within the first six weeks after birth excludes hip dysplasia in later life, as babies with a normal clinical and radiological examination at six weeks are assumed to be not requiring of further follow-up.³ However, there exists within the literature reports of acetabular dysplasia at four to six months of age in babies who had a normal initial screen. It is not clear what the causes of this are – either a later development of DDH or false negative scans. This study, therefore, sought to examine for the occurrence of late dysplasia in the breech group and to examine the effect of prophylactic treatment with a hip abduction device in those with normal screening. All

breech birth babies over an 18-month period in the originating centre were screened and those with normal hip screening at the six-week check were recruited and then randomized to either treatment with the Healthy Hip Diaper or into an observational group. The infants then underwent two-monthly checks, both clinically and with ultrasound scans, for the follow-up period of a year, with a final anteroposterior radiograph of the pelvis at 12 months of age. The study reports the outcomes of 340 breech babies who were assessed, with 16% being abnormal and treated with a Pavlik harness. Of the remaining patients, 90 were recruited into the trial with 43 in the treatment arm and 47 in the observational arm. Unfortunately, there was considerable crossover between the groups with 44% electing to be treated against their randomization and a successful follow-up rate of just 75%. Overall, 7.4% of the normal hip ultrasound patients subsequently were noted to have acetabular dysplasia at one year of age, one in the treatment group and four in the observational group, which was not statistically significant. The relatively high incidence of detection of DDH in breech babies after the initial six-week screen has implications for screening strategies, and in Scandinavian countries a modified screening including a hip radiograph at four to five years old is used due to relatively high acetabular dysplasia rates. However, the authors logically point out that if a radiograph is checked before the age of two years, then intervention could be limited to a less invasive procedure rather than a large pelvic osteotomy. The limitations of this study include the high crossover rate and the high degree of intra- and interobserver variability on the measurement of acetabular index and, hence, the diagnosis of dysplasia itself. The authors also correctly point out that their study demonstrates no statistically significant evidence that prophylactic abduction bracing from birth is indicated, but further study of this is required.

Contralateral slip SCFE: what's the risk?

Another paper, another controversial topic, this time concerning contralateral pinning of hips with unilateral slipped capital femoral epiphysis (SCFE). Patients presenting with a single sided slip can be prophylactically pinned on the contralateral side, which obviously carries the risk of complications in those patients who would not go on to develop a slip. If only there was a method of predicting the risk of contralateral slip, then a better judgement could be formed of the risks and benefits of this second, prophylactic intervention. This is precisely what the authors of this paper from **Boston (USA)** have attempted to do.⁴ They designed a study

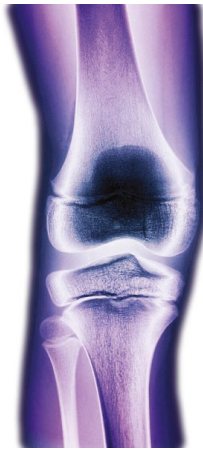
that sought to examine if the morphology of the femoral head-neck junction had any influence on the risk of subsequent contralateral slip, and also to determine what the threshold measurements and number needed to treat (NNT) to facilitate informed discussion with parents on the risks and benefits of contralateral intervention were. This is a radiological prognostic study based around measurements of the morphology of the femoral neck and head in a large cohort of patients. Both previously identified risk factors and some less well-known measurements were examined as potential prognosticators for contralateral slip. The authors reviewed all of the radiographs for over 300 patients and established the epiphyseal tilt and epiphyseal extension ratio, as well as the alpha angle and epiphysis angle of the uninvolved hip. The posterior slip angle, as visualized on a frog lateral, is a known risk factor of SCFE; however, the concept of the superior epiphyseal extension being protective is less well known – although it has previously been hypothesized as not being present in slipped hips. Multivariate logistic regression was performed and receiver operating characteristic (ROC) curves were constructed to determine the optimum measurements predictive of contralateral slip. Overall, 318 patients were included over a 17-year period with a mean age of 12 years and a minimum follow-up of 18 months; male to female split was essentially even. The lateral tilt angle and superior epiphyseal extension ratio were identified as independent factors associated with contralateral slip. Interestingly, for each degree, the posterior tilt increased contralateral slip probability by 8% and for each 0.01 increase in the superior epiphyseal extension ratio the risk of contralateral slip decreased by 6%. This work also found that a posterior tilt of $> 10^\circ$ confirmed a 49% risk of contralateral slip compared with a 19% chance of slip in $< 10^\circ$. The epiphyseal height was found to be an independent risk factor, but a cut-off score was not able to be quantified. Interestingly, this paper found that neither alpha angle nor epiphyseal angle were risk factors for slip, which is a contrarian position when considered alongside other published research. While this is interesting work, the measurements do strike us as quite subjective, and we suspect strong advocates of prophylactic pinning or otherwise will be relatively unmoved. Yet, all efforts to inform the debate should be welcomed.

Late detection of DDH in England?

A 26-year national study

Another worthy read on DDH is included in this issue of 360, again from the team in **Southampton (UK)**.⁵ As we know, DDH diagnosed later

than the age of a few months old is associated with poorer outcomes and increased complications. As such, since 1986 selective screening has been mostly standard practice across the UK. However, the experience in the UK is that late presentation of DDH continues to occur, as many of these children do not have the risk factors required to trigger a scan. Indeed, other European countries have universal screening programmes. The question asked by this thoughtful paper is are we right to do so? This universal screening approach does lead to a lower rate of late detected DDH (not zero as outlined by the previous paper) – but is costly, resource intensive, and may lead to overtreatment. This study uses ‘big data’ to examine the incidence of DDH diagnosed after the age of one year in England, and to assess for geographic distribution and any age or sex variability. The UK Clinical Practice Research Datalink (CPRD) and Hospital Episode Statistics (HES) databases were used to identify an ‘at risk’ population of over 3.5 million patients and a study population of 754 patients whose DDH was detected between the ages of one and eight years old. The UK Clinical Practice Research Datalink (CPRD) covers around 1:20 patients in the UK, while the HES database covers all treatment episodes. For the purposes of this paper, DDH due to neuromuscular diseases, syndromes, and trauma were excluded from the analysis. The current incidence of late diagnosis is 1.28 per thousand live births, which is higher than the rate recorded in some areas of England almost 40 years ago prior to the introduction of selective screening. This is, quite understandably, a huge concern. Unsurprisingly, the pickup rate was highest in the age group of one to two years as the diagnosis is often made as children start to walk and 86% of cases were detected by the age of three. There was no significant geographic variation between different regions of England, indicating that the problem remains a national one. Naturally, this paper suffers from many of the criticisms levelled at papers utilizing large databases, including accuracy of the primary coding and data integrity. Interestingly, one limitation introduced an underestimation, as cases diagnosed after six months of age could be construed to be late diagnoses but were unable to be studied due to the binary one-year age categorization. Overall, the authors conclude that the selective screening programme appears to have had little impact on the rates of late diagnosed DDH, which remains a significant cause of disability and litigation. The debate surrounding the optimal means of screening for DDH will continue, but this paper means that the debate is now better informed.



Multicentre study of physical abuse and limb fractures in young children

■ Physical child abuse is a sad fact of life and, while we cannot prevent all cases, it is vital that when such cases do present to hospital the opportunity is not missed for detection and intervention. This retrospective review across a whole geographical region in East Anglia (UK) led by a team of researchers from **Peterborough (UK)** aimed to examine if high standards of practice were occurring uniformly across the region and, if not, which areas of practice required improvement.⁶ Data was gathered over a four-year study period from seven different hospitals and included all high risk paediatric fractures. This was defined as all fractures in those age one year or less and all humeral and femoral fractures in children under three years. Supracondylar fractures were excluded. Review by a paediatrician was recorded, as were skeletal surveys. Multiagency case conference decisions were used as the definition of whether physical abuse had occurred. Relatively unsurprisingly, the at-risk groups for the diagnosis of non-accidental injury were all children under 12 months (10% patients) as well as femoral fractures under 18 months and humeral fractures under 24 months. Interestingly, there was a significant variation between paediatrician review and skeletal survey being undertaken between the hospitals; in one centre, only 46% of children who were under 12 months at time of fracture were reviewed by the paediatrics team. A decision of non-accidental injury was more common in centres with higher rates of paediatric review and use of skeletal survey; this does seem to suggest that the other cases are going undetected. This is the first multicentre review of non-accidental injury in the UK and it is of huge concern that there is such variation seen in practice. From their findings, the authors suggest that to minimize false negative assessments, all high-risk children should be assessed by a paediatrician prior to discharge

from the emergency department. Their proposed criteria seem very reasonable and includes any child under the age of 12 months with any fracture, under 18 months with a femur fracture, and under 24 months with a non-supracondylar humeral shaft fracture. Statistically, this should increase our detection rate, but we should all continue to be aware of the possibility of non-accidental injury in every case that we see.

The reproducibility of ultrasound-based metrics for assessing DDH

■ Ultrasound assessment is the mainstay radiological method of assessing developmental dysplasia of the hip (DDH), but its utility depends on the reproducibility of the examination as well as the accuracy, which incorporates both reliability and validity. There are a variety of imaging-based metrics reported for the assessment of DDH, the most widespread in clinical use being the Graf acetabular alpha angle. One challenge of assessing the diagnostic accuracy of this test has been the historical variation in what constitutes normal. Indeed, many studies use the outcomes of later examinations such as plain film radiograph at two years of age as a proxy, which assumes that spontaneous resolution of dysplasia is not possible, which of course it is. This study from **Vancouver (Canada)** aimed to perform a systematic review of reported DDH diagnosis using ultrasound, and hence to estimate and compare the levels of reproducibility in the available DDH metrics.⁷ Following an extensive literature review, 28 studies were included in the overall analysis and the overall evidence quality of these was graded as moderate. Of all the metrics assessed, Graf’s alpha angle demonstrated the least inter-examination variability, which was 10% lower than the variability of the beta angle measurement, the next best available. Both of these measurements had lower variability when contrasted with other metrics of dysplasia. However, despite this finding, the authors found the actual variability in measurement was sufficiently high to be clinically problematic, a conclusion that was supported by the low reported levels of intraclass correlation and Kappa coefficient values. Furthermore, evidence of a deterioration of reproducibility over time was suggested, which is in itself concerning. What is reported here is somewhat disheartening; overall, there was high variability and low agreement in dysplasia metrics. The failure to maintain standards over three decades indicates that work is urgently needed in this area to make improvements, as the implication of not accurately measuring what we are looking for has huge implications for a test that is the mainstay of early screening programmes.

Are inflatable play structures really safe for our children? X-ref

■ After some pretty involved and high-quality papers in this issue of 360, a slightly more light-hearted pick from our reviewers is included. Most of us will be familiar with the increase in paediatric injuries associated with good weather and public holidays, and many of these occur on inflatable toys such as bouncy castles. This group from **Palma de Majorca (Spain)** conducted a review to investigate the risks posed by inflatable play structures and make suggestions for the mitigation of these risks.⁸ The mechanism of such injuries is varied and includes a fall both inside and outside of the bouncy castle, collision between children of differing sizes, and failure of the equipment itself, including the anchoring system. Over a one-year period, 114 children were treated for injuries sustained on inflatable play structures. In younger children, boys were more frequently injured, but the gender distribution was even after the age of ten years. In the upper limb, the most commonly injured region was the humerus, with supracondylar fractures forming the majority. The distal radius was also frequently injured. The most common injury in the lower limb was a sprain followed by a tibial fracture. Worryingly, in this series two

patients presented with lumbar vertebral fractures. Unsurprisingly, injuries were more common in the summer months, over half of patients had an unwitnessed fall, and almost half of parents were not supervising or in the vicinity of the bouncy castle at the time of injury. It is obvious that these structures pose a risk of injury and the authors make a number of recommendations, mainly on a common sense basis, to ameliorate such risks. These include attention to and regulation of the equipment itself as well as prohibiting children of different sizes and ages to play simultaneously. Furthermore, responsible and close adult supervision is strongly advocated, and the authors go so far as to suggest that children under the age of six should be prohibited from using such structures, anticipating a reduction in the burden of injury of 34%. Of course, it is impossible to calculate the number of children using such structures and, therefore, the raw injury rates. Fatalities and life-changing injuries have occurred and so this is a serious topic, and both regulatory change and public education are required to mitigate risks.

REFERENCES

1. Sankar WN, Gornitzky AL, Clarke NMP, et al. Closed reduction for developmental dysplasia of the hip: early-term

results from a prospective, multicenter cohort. *J Pediatr Orthop* 2019;39:111-118.

2. Eidelman M, Keshet D, Nelson S, Bor N. Intermediate to long-term results of femoral neck lengthening (Morscher osteotomy). *J Pediatr Orthop* 2019;39:181-186.

3. Morris AR, Thomas JMC, Readin IC, Clarke NMP. Does late hip dysplasia occur after normal ultrasound screening in breech babies? *J Pediatr Orthop* 2019;39:187-192.

4. Maranhão DA, Ferrer MG, Kim YJ, Miller PE, Novais EN. Predicting risk of contralateral slip in unilateral slipped capital femoral epiphysis: posterior epiphyseal tilt increases and superior epiphyseal extension reduces risk. *J Bone Joint Surg [Am]* 2019;101-A:209-217.

5. Broadhurst C, Rhodes AML, Harper P, et al. What is the incidence of late detection of developmental dysplasia of the hip in England? A 26-year national study of children diagnosed after the age of one. *Bone Joint J* 2019;101-B:281-287.

6. Mitchell PD, Brown R, Wang T, et al. Multicentre study of physical abuse and limb fractures in young children in the East Anglia Region. *Arch Dis Child* 2019. (Epub ahead of print) PMID: 30636223.

7. Quader N, Schaeffer EK, Hodgson AJ, Abugharbieh R, Mulpuri K. A systematic review and meta-analysis on the reproducibility of ultrasound-based metrics for assessing developmental dysplasia of the hip. *J Pediatr Orthop* 2018;38:e3015-e3311.

8. Corominas L, Fernandez-Ansorena A, Martinez-Cepas P, Sanpera J, Obieta A. Are inflatable play structures really safe for our children? *Journal of Children's Orthopaedics* 2018;12:282-287.

Research

X-ref For other Roundups in this issue that cross-reference with Research see: **Foot & Ankle Roundup 4**.

Preoperative opioid use and complications X-ref

■ Multiple studies have been published evaluating the effect of preoperative opioid use and postoperative outcomes. It will come as no surprise to any reader of 360, given the North American opioid crisis and the subsequent column inches in all journals given up to this dramatic problem, that research has now turned not only to quantifying the problem, but ascertaining what the potential risks in the surgical patient are. The majority of these previous investigations have defined preoperative use as any opioid consumption within one year prior to surgery, which is unlikely to be appropriate to drawing rigorous conclusions. Furthermore, there is as yet no evidence correlating the number and duration of opioids used and potential postoperative complications. To clarify this tumultuous situation, a group from **Columbus, Ohio (USA)** has investigated

preoperative opiate use prior to large joint arthroplasty and lumbar fusion and correlated it to postoperative complications.¹ This group used national insurance claims data between 2007 and 2015 to identify their cohort of 58 082 primary total knee arthroplasties (TKAs), total hip arthroplasties (THAs), and single- or two-level posterior lumbar fusions (PLFs) carried out to treat spondylosis. The group then divided preoperative opioid use into three categories (naive, three months or less, three to six months, more than six months but stopped three months before surgery, and more than six months of continuous use) and, by using these categorized outcomes, set out to establish if there was a link between opioid use and duration with adverse surgical outcomes. Using this large cohort, the group identified that preoperative opioid use of more than three months was associated with an increased likelihood of a visit to the emergency department within 90 days postoperatively if a patient had undergone TKA. If patients used opioids for greater than 90 days preoperatively, they showed a higher risk of postoperative emergency department assessment for all

causes. Patients also demonstrated a higher rate of wound dehiscence, infection, hospital re-admission within 90 days, and revision surgery within one year after TKA, THA, and PLF. In cases where preoperative opioids were ceased at least three months preoperatively, the team report a significant reduction in the risk of any adverse outcomes, with the greatest reduction seen after THA and PLF. This study intelligently separates out preoperative opioid cessation three months prior to surgery and identifies that this patient cohort is not at an elevated risk of postoperative complications. Patients who are using opioids should be counselled to stop use three months prior to surgery to reduce their likelihood of postoperative complications, particularly when they have been using these medications for six months or more.

CT-based cross-sectional evaluation of muscular atrophy and fatty degeneration around the pelvis and the femur

■ In order to successfully rehabilitate after hip arthroplasty, patients need sufficient muscle