CHILDREN’S ORTHOPAEDICS

The treatment of an unstable slipped capital femoral epiphysis by either intracapsular cuneiform osteotomy or pinning in situ

A COMPARATIVE STUDY

We undertook a retrospective comparative study of all patients with an unstable slipped capital femoral epiphysis presenting to a single centre between 1998 and 2011. There were 45 patients (46 hips; mean age 12.6 years; 9 to 14); 16 hips underwent intracapsular cuneiform osteotomy and 30 underwent pinning in situ, with varying degrees of serendipitous reduction. No patient in the osteotomy group was lost to follow-up, which was undertaken at a mean of 28 months (11 to 48); four patients in the pinning in situ group were lost to follow-up, which occurred at a mean of 30 months (10 to 50). Avascular necrosis (AVN) occurred in four hips (25%) following osteotomy and in 11 (42%) following pinning in situ. AVN was not seen in five hips for which osteotomy was undertaken >13 days after presentation. AVN occurred in four of ten (40%) hips undergoing emergency pinning in situ, compared with four of 15 (47%) undergoing non-emergency pinning. The rate of AVN was 67% (four of six) in those undergoing pinning on the second or third day after presentation. Pinning in situ following complete reduction led to AVN in four out of five cases (80%). In comparison, pinning in situ following incomplete reduction led to AVN in 7 of 21 cases (33%). The rate of development of AVN was significantly higher following pinning in situ with complete reduction than following intracapsular osteotomy (p = 0.048). Complete reduction was more frequent in those treated by emergency pinning and was strongly associated with AVN (p = 0.005).

Non-emergency intracapsular osteotomy may have a protective effect on the epiphyseal vasculature and should be undertaken with a delay of at least two weeks. The place of emergency pinning in situ in these patients needs to be re-evaluated, possibly in favour of an emergency open procedure or delayed intracapsular osteotomy. Non-emergency pinning in situ should be undertaken after a delay of at least five days, with the greatest risk at two and three days after presentation. Intracapsular osteotomy should be undertaken after a delay of at least 14 days. In our experience, closed epiphyseal reduction is harmful.

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The management of unstable slipped capital femoral epiphysis (SCFE) is contentious. Loder et al’s landmark paper1 highlighted avascular necrosis (AVN) as the most feared complication of this condition, with an incidence of 47%. More recently, of the presence of femoroacetabular impingement (FAI) has been increasingly recognised and in published series has led to total hip arthroplasty (THA) in the absence of AVN. Dodd, McCormack and Mulhall2 described 49 patients with stable and unstable SCFE, of whom 32% had clinical signs of FAI at 6.1 years. An operation that can restore normal anatomy without increasing the risk of AVN has thus far proved elusive. Whether an unstable SCFE should be reduced, whether this should be closed, open, or open incorporating a shortening neck osteotomy, remains controversial. A survey of members of the European Paediatric Orthopaedic Society in 2011 revealed that, for unstable severe slips, only 11% of members would advocate an open reduction, whereas most would recommend closed reduction, either using positioning on a routine operating table (46%), or more forcefully with traction and manipulation (35%). Only 8% of members indicated that they would deliberately avoid epiphyseal reduction.3 An equivalent survey was conducted in America in 2005, with similar findings, although 27% of respondents did not routinely use the stable/unstable concept.4

There are several studies (Table I)5,6 documenting variable rates of AVN for unstable SCFEs treated by pinning in situ. Those studies published before Loder et al’s paper1 include ‘unstable equivalent’ hips and may not represent the same pathological process. This
includes Peterson et al’s paper,7 which is commonly quoted as the largest series of unstable SCFEs. Since 2000, four series have reported rates of AVN between 0% and 13%,8-11 although only the work of Parsch11 involved > 30 patients. It is likely that the true rate of AVN in unstable SCFE treated by pinning in situ is not known.

Much has been written about the use of intracapsular osteotomy in patients with SCFE; however, this work pertains predominantly to stable slips, with only two series of unstable SCFEs (Table II).12 Rates of AVN of between 3% and 30% have been reported in the past, which many feel to be unacceptably high in patients who had a low predisposition to AVN at the time of presentation.13-18 More recently, surgical dislocation of the hip combined with cuneiform osteotomy has been described, with encouraging results, although all but one series involved mainly stable SCFEs.19-22 One centre from Brazil has published preliminary results of arthroscopic cuneiform osteotomy, with one of a total of five patients developing AVN.23

Sankar et al22 have recently reported the use of a modified intracapsular osteotomy, undertaken following surgical dislocation of the hip, with an encouraging AVN rate of 26% in 27 hips. There was also a 15% rate of implant failure, although the method of fixation varied between patients.

Biring, Hashemi-Nejad and Caterall24 reported a series of 25 patients with SCFE, 23 of which were unstable. They were treated with bed rest and ‘slings and springs’ for three weeks, followed by open cuneiform osteotomy without surgical dislocation. At a mean follow-up of eight years the rate of AVN was 13%; chondrolysis was seen in 17%. The mean Iowa hip score25 was 93.7/100, indicating a low incidence of FAI.

The timing of surgery for patients with unstable SCFE is also controversial. Although the work of Peterson et al7 supports urgent intervention within 24 hours, this was measured from the time of admission to hospital, rather than from the onset of symptoms. However, those hips that were pinned in situ developed AVN less frequently when treated urgently. Other evidence is equivocal, with the series of Loder et al1 conversely showing a higher rate of AVN in urgently treated patients. There is no high-level evidence to guide the timing of surgery in these patients. We have previously proposed the concept of an ‘unsafe window’ between 24 hours and one week. In our earlier retrospective series of 16 unstable slips, eight developed AVN, all of whom underwent surgery within this period.26 Although Biring et al24 showed encouraging results when cuneiform osteotomy for unstable SCFEs was delayed for a minimum of three weeks, there was no comparison with those undergoing this procedure earlier.

| Table I. Evidence base for pinning in situ in unstable Slipped Capital Femoral Epiphysis and the incidence of avascular necrosis (AVN) according to the delay in presentation |
|---|---|---|---|---|---|
| Total no. of hips | Capsulotomy | Severity of slip | % AVN < 24 h | % AVN > 24 hrs | Total % AVN |
| Casey 1972*5 | 23 | No | Mixed | 66 | 15 | 22 |
| Aadelen 1974*6 | 47 | No | Mixed | 0 | 23 | 15 |
| Loder 1993*7 | 30 | No | Mixed | 80 | 40 | 47 |
| Peterson 1997*7 | 91 | No | Mixed | 7 | 20 | 14 |
| Phillips 2001*8 | 14 | No | Mixed | 0 | - | 0 |
| Gordon 2002*9 | 16 | Yes | Mixed | 0 | 33 | 13 |
| Chen 2009*10 | 30 | 70% | Mixed | 13 | - | 13 |
| Parsch 2009*11 | 64 | Yes | Mixed | 5 | - | 5 |

* Includes assumed ‘unstable-equivalent’ cases

| Table II. Evidence base for intracapsular osteotomy in stable and unstable Slipped Capital Femoral Epiphysis (SCFE) and the incidence of avascular necrosis (AVN) and chondrolysis |
|---|---|---|---|---|---|
| Study | Total no. of hips | Unstable SCFE | Severity of slip | AVN (%) | Chondrolysis |
| Hagglund 198613 | 33 | - | All severe | 30 | - |
| Fish 199414 | 66 | - | Mixed | 3 | 5 |
| De Rosa 199615 | 27 | - | All severe | 15 | - |
| Velasco 199816 | 60 | - | Mixed | 12 | 13 |
| Fron 200017 | 50 | - | All severe | 14 | - |
| Barros 200018 | 23 | - | All severe | 13 | - |
| Biring 200619 | 25 | 23 | All severe | 13 | 17 |
| Leunig 2007*20 | 30 | - | Mixed | 0 | - |
| Lawane 2009*21 | 25 | - | All severe | 16 | 12 |
| Slongo 2010*22 | 23 | 3 | Mixed | 7 | - |
| Akkari 2010†23 | 5 | - | All severe | 20 | - |
| Huber 2011†24 | 30 | 3 | Mixed | 3 | - |
| Sankar 2013‡25 | 27 | 27 | Mixed | 26 | - |

* Three weeks pre-operative treatment with ‘slings and springs’
† With surgical dislocation
‡ Arthroscopic
Pinning *in situ* remains the popular approach for unstable SCFE, presumably due to the perceived lower incidence of AVN and shorter operating time. Both in theory and with some evidence from Biring et al., intracapsular osteotomy offers the potential to restore the anatomical relationships of the proximal femur towards normality, which may theoretically reduce the incidence of FAI and subsequent degenerative change. There is little evidence concerning both methods of treatment; in particular, there is no comparative evidence to ascertain whether the perceived high risk of AVN after intracapsular osteotomy is a reality. The question of the timing of surgery in unstable SCFE is unanswered.

The aim of this study was to compare the outcome of intracapsular osteotomy with pinning *in situ* in patients with an unstable SCFE. In addition, comparative data concerning the timing of surgery of both forms of treatment is discussed. The null hypotheses were that the rate of AVN is the same after both forms of treatment, and that the timing of treatment does not affect the rate of AVN after either form of treatment.

**Patients and Methods**

This was a retrospective single-centre comparative study. The medical records of 226 consecutive patients who presented to our institution with a diagnosis of SCFE between 1998 and 2011 were initially reviewed. In all cases the date of presentation was after the publication of the paper by Loder et al., and none were excluded.

Although some patients had a prodromal period of less severe symptoms, care was taken to establish the time at which each patient became unable to bear weight, according to the definition of stability described by Loder et al. This was taken as a marker from which the timing of the operation was taken.

**Surgical technique.** Intracapsular osteotomy was employed according to the preference of the surgeon, when it was deemed that there would be significant technical difficulties to undertake pinning *in situ*. For intracapsular osteotomy, patients were gently positioned supine on a traction table and a standard anterior surgical approach with an ‘H’-shaped capsulotomy was used. A metaphyseal trapezoidal section was removed in slices, taking great care to respect the posterior vasculature. The physis was meticulously excised on both sides of the osteotomy and the epiphysis was gently reduced under fluoroscopic guidance. Stabilisation was achieved with one partially threaded cannulated screw. Patients were advised to remain non-weight-bearing for 12 weeks post-operatively. Intra-operative photographs and radiographs are shown in Figures 1 to 4.
was introduced percutaneously. No capsulotomy or capsular aspiration was undertaken.

AVN appeared on plain radiographs (AP pelvis +/- frog leg lateral) as fragmentation and collapse of the capital femoral epiphysis. AVN was defined as ‘total head involvement’ or ‘sectoral’ following retrospective review of the latest follow-up radiographs and full agreement by the senior authors (AB and CB).

Statistical analysis. The incidence of AVN was compared between the two surgical techniques using Pearson’s chi-squared test, with p = 0.05 taken to represent significance. Pearson’s chi-squared test was also used to analyse the incidence of right- versus left-sided slips. Means with range are provided, where appropriate.

Results
In all, there were 46 unstable SCFEs in 45 patients, as defined by the criterion of Loder et al.1 ‘unable to bear weight with or without crutches’. The mean age of the patients was 12.6 years (9 to 14), and gender distribution was even. There was a significant preponderance of left-sided slips (p = 0.03, Pearson’s chi-squared test) (Table III).

A total of 16 patients underwent intracapsular osteotomy and 30 underwent pinning in situ. Although no deliberate attempt at reduction was made in the latter group, all slips reduced serendipitously to varying extents. This was complete in six patients and incomplete in 24.

In the intracapsular osteotomy group, no patient was lost to follow-up, which was undertaken at a mean of 28 months (11 to 48). In one patient in each group it was not possible to determine the onset of instability, and so these two patients were not included in the analysis of timing to surgery.

Four patients in the pinning in situ group were lost to follow-up, which was undertaken at a mean of 30 months (10 to 50). There was no difference noted in demographics or the side of the SCFE between the groups (Table III).

For the entire cohort of patients the rate of AVN was 36% (15/42) following adjustment for those lost to follow-up. Of the 16 SCFEs treated by intracapsular osteotomy, AVN developed in four hips (25%). In contrast, of the 26 SCFEs treated by pinning in situ, AVN developed in 11 (42%). This difference was not significant (p = 0.2556). The pinning in situ group was stratified by the extent of serendipitous reduction. Following adjustment for those lost to follow-up, complete reduction led to AVN in four of five hips (80%) and in seven of 21 (33%) in which reduction was incomplete. The rate of the development of AVN was significantly higher in those treated by pinning in situ with complete reduction, than in those treated by intracapsular osteotomy (80% vs 25%) (p = 0.048, Pearson’s chi-squared) (Table IV).

The degree of AVN was typically total head involvement in both groups. One of four hips with AVN in the intracapsular osteotomy group and one of 11 hips with AVN in the pinning in situ group involved the superolateral quadrant exclusively.

A total of 11 patients underwent further surgery. In ten patients, this was in relation to AVN and in an additional case, due to a secondary fracture at the site of the screw which required screw exchange. Screw removal alone was carried out in five patients. Two patients underwent screw removal, followed by hip distraction with an external fixator and a subsequent pelvic support osteotomy. In one, screw purchase was lost and revision fixation with two screws was required. One patient underwent screw
removal, followed by hip distraction with an external fixator and concurrent excision arthroplasty with gluteal interposition. A final patient was treated with screw removal and subsequent valgus femoral osteotomy.

In some patients, the unstable SCFE occurred after a prodromal period of symptoms. The sample was further sub-analysed for ‘acute’ versus ‘acute-on-chronic’ slips. There were a total of 29 acute SCFEs and 12 acute-on-chronic SCFEs, and in five SCFEs there was insufficient information to assess the chronicity.

In all, 11 hips (69%) treated with intracapsular osteotomy and 18 (72%) of those treated by pinning in situ (after correcting for those with insufficient documentation) were acute. Of the five hips treated by pinning in situ with complete reduction and sufficient follow-up, four were acute. There was no association between the chronicity of symptoms and the incidence of AVN (p = 0.5762, Pearson’s chi-squared test). In the intracapsular osteotomy group, three of 11 acute cases and one of five acute-on-chronic cases developed AVN. In the pinning in situ group, eight of 16 acute cases and two of six acute-on-chronic cases developed AVN. Of those with complete reduction, only one did not develop AVN; this was an acute slip.

Heterotopic ossification and meralgia paraesthetica were complications particular to intracapsular osteotomy, both seen in two hips (12.5%). Heterotopic ossification was diagnosed on plain imaging following agreement by the senior authors (AB and CB). This was symptomatic in one patient, with symptoms resolving after treatment with oral indomethacin. One patient treated by pinning in situ suffered a fracture of the femoral neck at the site of entry of the screw, eight months following the initial procedure. This required further fixation.

With respect to the timing of surgery, intracapsular osteotomy was carried out at a mean of 12.1 days (7 to 25) after unstable symptoms began. The four hips treated in this way that developed AVN underwent surgery at a mean of 9.75 days (7 to 13) after unstable symptoms began. The patient who underwent surgery 13 days after unstable symptoms began and developed AVN failed to comply with post-operative non-weight-bearing instructions. Of the five hips that were treated > 14 days after unstable symptoms began, none developed AVN, although these differences were not statistically significant (p = 0.0986, Pearson’s chi-squared test) (Table V).

In 12 SCFEs pinning in situ was undertaken preferentially on an emergency basis, within 24 hours of unstable symptoms. Surgery in the remaining patients was undertaken between 24 hours and eight days after unstable symptoms began this delay being for logistical reasons or due to delayed presentation, particularly during the early years of the study, which includes patients reported in our earlier paper.26 Following adjustment for those lost to follow-up and without adequate documentation of the onset of symptoms, the rate of development of AVN in those treated by emergency pinning in situ was 40% (four of ten) compared with 47% (four of 15) in those treated by non-emergency pinning in situ. The highest rate of AVN was seen in those treated two or three days after unstable symptoms began (4/6; 67%). There was no significant difference in the rate of development of AVN or reoperation, depending on the timing of surgery (Table VI).

Complete reduction occurred almost exclusively when pinning in situ was used as an emergency (6/14 hips; 43%) and was only seen once in non-emergency cases (6%). This difference approached significance (p = 0.056, Pearson’s chi-squared test). Of the 12 SCFEs treated as an emergency, five had complete reduction; one was subsequently lost to follow-up and the remaining four developing AVN. A total of seven SCFEs reduced incompletely, with one being lost to follow-up; none of the remaining six developed AVN. Emergency pinning in situ with complete reduction was strongly predictive for AVN, compared with emergency pinning in situ with incomplete reduction (p = 0.005, Pearson’s chi-squared test).

Discussion
It has recently been shown that intracapsular osteotomy may limit the development of FAI after the treatment of a stable SCFE, with some evidence suggesting that this may also be the case for unstable SCFEs.23,24 In this study we have shown that, in our hands, intracapsular osteotomy does not have an increased rate of AVN compared with pinning in situ in patients with an unstable SCFE. Furthermore, and strikingly, it appears that intracapsular osteotomy may have a protective effect on the vasculature of the femoral head. This finding reached significance when the intracapsular osteotomy group was analysed against the pinning in situ subgroup with complete reduction (p = 0.0271, Pearson’s chi-squared test). Our findings support those of Birring et al24 and Sankar et al.22 Whereas the latter authors undertook osteotomy via surgical dislocation of the femoral head, we have described an acceptable alternative method, with equivalent results.

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### Table V. Effect of the timing of surgery in the intracapsular osteotomy group (following adjustment) and the development of avascular necrosis (AVN)

<table>
<thead>
<tr>
<th>Timing of procedure following onset of instability</th>
<th>Rate of AVN (%)</th>
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<tbody>
<tr>
<td>Days 7 to 13 (10)</td>
<td>4 (40)</td>
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<tr>
<td>Day 14 onwards (5)</td>
<td>0</td>
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</tbody>
</table>

### Table VI. Effect of the timing of surgery in the pinning in situ group (following adjustment) and the development of avascular necrosis (AVN)

<table>
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<tr>
<th>Timing of procedure following onset of instability</th>
<th>Rate of AVN (%)</th>
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<tr>
<td>Within 24 hours (10)</td>
<td>4 (40)</td>
</tr>
<tr>
<td>Days 2 to 3 (6)</td>
<td>4 (67)</td>
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<tr>
<td>Day 5 onwards (9)</td>
<td>3 (33)</td>
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The ideal treatment for an unstable SCFE would restore the normal anatomy, avoid FAI and achieve a low rate of AVN. It seems that intracapsular osteotomy might reduce the incidence of both FAI and AVN. Intuitively, an open approach, capsulotomy and instrumentation of the femoral neck would put the vasculature at risk. However, we suggest that our findings are rational. Opening the capsule may remove the tamponade effect; Herrera-Soto et al.\(^{27}\) have reported a twofold rise in intracapsular pressure in SCFE and a threefold rise if the epiphysis is reduced. Relief of intracapsular pressure may enable greater blood flow to the epiphysis, and anatomical restoration of the neck may resolve kinking and tension on the vessels. Finally, complete excision of the physis may remove a barrier to the ingrowth of metaphyseal vessels and allow revascularisation. There is some evidence to suggest that the severity of the slip is an independent predictor of AVN.\(^{28}\) This would suggest that all our patients who underwent intracapsular osteotomy had an initially higher predisposition to AVN, as this procedure was predominantly undertaken in hips in which the severity of the slip was felt to make pinning \textit{in situ} technically difficult. With this in mind, our results are all the more striking.

All patients treated by pinning \textit{in situ} underwent serendipitous closed reduction to some extent, in an unpredictable fashion. When closed reduction was complete, the rates of AVN were higher. Complete reduction was more likely to occur within the first 24 hours after presentation. Closed reduction and pinning \textit{in situ} has been shown to be favoured in Europe as recently as 2011.\(^3\) Our experience raises questions regarding this practice. We suggest that imaging of an unstable SCFE represents a snapshot of a dynamic process. Physeal instability results in a mobile epiphysis, leading to serendipitous reduction. We feel that physeal instability is probably a continuum, rather than obeying the binary classification described by Loder et al.\(^1\) It is likely that an unknown determinant in the pathophysiology of SCFE leads to more significant physeal instability in some hips, which are subsequently more prone to physeal mobility, serendipitous reduction and AVN. It is unclear whether the propensity to develop AVN is caused by serendipitous reduction, or whether this is a marker of more significant underlying instability, which in itself may have a tendency to a poor outcome.

Capsulotomy was not performed in the hips we treated by pinning \textit{in situ}; in retrospect, this may be a useful adjunct and may explain why the results of pinning \textit{in situ} are not as favourable as in some previous series, in which capsular decompression was performed in some form.\(^{9-11}\) We note that some of those series contained ‘unstable-equivalent’ hips. We have detailed our belief that physeal instability represents a continuum. It is, however, currently impossible to determine where a patient lies along this spectrum and comparison of our results with others may be inappropriate due to heterogeneity within and between series. From two series of 16 and 30 patients, respectively, Gordon et al.\(^9\) and Chen et al.\(^{10}\) have suggested that emergency pinning \textit{in situ}, combined with capsulotomy for an unstable SCFE has a low rate of AVN. Parsch et al.\(^{11}\) achieved a low rate of AVN of 4.7% in a larger group of 64 unstable SCFEs. In contrast to other published series, Parsch’s group\(^{11}\) performed emergency open reduction, without osteotomy, and fixed the epiphysis with multiple Kirschner wires. It is possible that any potential benefit of emergency pinning \textit{in situ} was masked in our series by the lack of formal capsulotomy. In this subgroup in our study the distinction between good and poor outcomes seems to be governed by the degree of epiphyseal reduction. The hips with complete reduction had a very poor outcome and may have stood to gain most from capsular decompression. There has previously been difficulty in determining whether emergency timing or formal capsulotomy is the major factor determining the good results reported by Parsh et al.;\(^{11}\) our findings would suggest it to be the latter.

When osteotomy was delayed for a minimum of two weeks from the onset of symptoms, our results concur with those of Biring et al.\(^{24}\) and Sankar et al.,\(^{22}\) who have provided the only other data concerning intracapsular osteotomy in unstable SCFE. Biring et al.\(^{24}\) advocate a preoperative delay of at least three weeks. In our experience, intervention between the seventh and 14th days after presentation is harmful, representing an ‘unsafe window’ of relative epiphyseal vulnerability. We suggest that, following this period, the physis stabilises to some degree, making the intervention more benign. We did not study the effect of intracapsular osteotomy undertaken within one week of the development of symptoms. Parsch et al.\(^{11}\) have provided robust data to suggest that emergency open reduction, without osteotomy, is beneficial; it would follow that emergency intracapsular osteotomy may also be beneficial.

Our earlier study discussed the concept of an ‘unsafe window’ for pinning \textit{in situ} in unstable SCFE between two and seven days after the onset of symptoms.\(^{26}\) In this up-to-date and larger series, surgery two or three days after presentation seems to be particularly contraindicated. We have no data for the fourth day after presentation, and have consequently defined an updated ‘unsafe window’ as between the second and fifth days.

Emergency pinning \textit{in situ} in unstable SCFEs requires reevaluation. In the absence of complete closed reduction, results appear to be reasonable. However, we found that complete closed reduction without decompression is more likely in the emergency setting and leads to poor results. We have discontinued the practice of emergency closed pinning \textit{in situ} in favour of an emergency open reduction, or delayed intracapsular osteotomy.

This series included a significantly higher number of left-sided SCFEs (\(p = 0.03\)). We suggest that this may be explained by a predominance of right-foot-dominant individuals. As seen in sporting activities, these patients lead with their left foot during a sharp forward movement. Studies of anterior cruciate ligament injuries have shown that limb dominance is predictive for the injured side.\(^{29,30}\)
There is currently little information about the use of intracapsular osteotomy in unstable SCFE. Comparison of existing series of intracapsular osteotomy and pinning in situ is fraught with error, as a result of differing methodologies and heterogeneous groups. This first comparative study of unstable SCFE is therefore a worthwhile addition to the evidence base and raises questions of current opinion. Since the work of Parsch et al.,11 this represents the second largest study of unstable SCFEs without ‘unstable-equivalent’ cases.

There are shortcomings to this study, which could be addressed to produce more robust data in forthcoming papers. The retrospective methodology is common to most of the literature on unstable SCFEs. We were unable to achieve a complete data set, due to shortcomings with documentation and follow-up, although full data were available to calculate the rates of AVN in 91% of cases and the effect of surgical timing in 87%. Although we have presented a large number of patients with this rare condition, the subgroups with respect to intervention and the timing of surgery are small.

In our experience, the chronicity of symptoms was not predictive of the development of AVN. It is, however, likely that the practice of reducing an acute-on-chronic SCFE to a position beyond that in which it lay during its chronic phase would be detrimental. We may have insufficient numbers in our subgroups to have demonstrated this. We feel that an open early reduction, or late intracapsular osteotomy, may be of benefit in this situation to prevent over-reduction.

We were unable to determine whether AVN was predefined in some hips by the nature of the pathology, or whether it developed because of the intervention. Some units use pre-operative MRI and intra-operative blood flow measurements.31-33 These additions might add to the reliability of the data produced.

The key to a good outcome in unstable SCFE remains elusive: it may depend on capsular decompression, the restoration of normal anatomy, the exact nature of the surgical procedure, or its timing. A prospective randomised multicentre trial is strongly indicated to test those interventions that have been shown to have more favourable outcomes, such as emergency open reduction as reported by Parsch et al.,11 and delayed intracapsular osteotomy as reported here and by Birring et al.22

References


