Current Practice in the Management of Slipped Capital Femoral Epiphysis

Dinesh P. Thawrani, MD, FACS, David S. Feldman, MD, and Debra A. Sala, MS, PT

Background: The most widely used treatment for slipped capital femoral epiphysis (SCFE) is in situ fixation. In an attempt to reduce the chances of impingement, osteoarthritis, and osteonecrosis, surgeons have started adopting newer surgical techniques. The purpose of this study was to determine the current pattern of treating SCFE.

Methods: A questionnaire was sent electronically to all of the members of the Pediatric Orthopaedic Society of North America. The data were analyzed dividing surgeons into academic versus private practice, years of practice, and number of SCFEs treated per year.

Results: Of 990 members, 277 (28%) responded to the survey. Type of practice (academic, n = 181 vs. private, n = 51): For unstable severe SCFE, surgeons in academic practice use the surgical hip dislocation (SHD) approach significantly more frequently (35.7% vs. 14.9%; $P = 0.02$). A radiolucent table is used significantly more frequently in academic practice for both stable (50.6% vs. 29.8%; $P = 0.01$) and unstable (39.6% vs. 15.2%; $P = 0.002$) SCFE. Fully threaded cannulated screws (44.4% vs. 27.1%; $P = 0.03$), open capsular decompression (63.9% vs. 32.4%; $P = 0.001$), contralateral pinning (79% vs. 58.7%; $P = 0.005$), and postoperative magnetic resonance imaging (MRI) (15.5% vs. 3.9%; $P = 0.03$) are significantly more frequent in academic practice. Years of practice ($\leq$15 y, n = 124 vs. >15 y, n = 140): For severe stable SCFE, surgeons practicing for $\leq$15 years do acute osteotomies significantly less frequently (1.8% vs. 9%; $P = 0.004$) and perform SHD significantly more frequently (20.2% vs. 8.2%; $P = 0.004$). For unstable moderate SCFE, SHD is utilized significantly more frequently by surgeons $\leq$15 years in practice (29.8% vs. 16.5%; $P = 0.04$). Bilateral frog-leg lateral views (86.4% vs. 73.7%; $P = 0.04$), preoperative MRI (36.1% vs. 20.6%; $P = 0.006$), open capsular decompression (69.3% vs. 51.7%; $P = 0.01$) are significantly more frequent among surgeons $\leq$15 years in practice. Number of SCFE treated per year (< 10, n = 129 vs. $\geq$10, n = 136): For unstable severe SCFE, surgeons treating $\geq$10/y perform SHD significantly more frequently (38.6% vs. 26.1%; $P = 0.02$) and do in situ fixation with manual reduction significantly less frequently (11.8% vs. 21.8%; $P = 0.02$). Radiolucent table (54.3% vs. 38%; $P = 0.01$), 7.5 mm screw versus 6.5 mm (62% vs. 45.4%; $P = 0.01$), contralateral pinning (78.9% vs. 67.8%; $P = 0.04$), postoperative MRI (17.6% vs. 9.3%; $P = 0.04$), and postoperative computed tomography (14.7% vs. 7%; 0.04) are significantly more frequent among surgeons doing $\geq$10/y. Elective implant removal is more common among surgeons treating <10/y (16.2% vs. 6.9%; $P = 0.02$).

Conclusions: Treatment of SCFE varies significantly depending on the surgeon's type of practice, years in practice, and numbers treated per year. Surgeons in academic practice, surgeons with $\leq$15 years in practice, and surgeons treating greater number of SCFEs are more likely to use SHD to acutely reduce the slip.

Key Words: slipped capital femoral epiphysis, surgical hip dislocation, in situ pinning, femoroacetabular impingement, SCFE, FAI

(*J Pediatr Orthop* 2016;36:e27–e37)

The most widely used treatment for slipped capital femoral epiphysis (SCFE) is in situ fixation. However, improved understanding of hip pathoanatomy and the concept of femoroacetabular impingement (FAI) has led to the realization that at times in situ fixation may not be adequate to completely treat SCFE. It often leaves the anterior metaphysis of the proximal femur exposed to the acetabulum, which potentially can lead to future FAI, acetabular cartilage damage, and early hip joint degeneration in young adults.[1–3] Moreover, unstable SCFE is also associated with a relatively high incidence of avascular necrosis (AVN) of the femoral head.[4–7] An alternative surgical approach for SCFE is surgical hip dislocation (SHD) as described by Ganz and colleagues. It provides surgeons with a technique to acutely reduce the SCFE and possibly lessen the chance of FAI and AVN.[8,9] Despite controversy in the indications and outcomes of this surgical technique, more surgeons are receiving training in the technique, and the frequency of its use in the management of SCFE has increased in the last several years. Therefore, in situ fixation no longer remains the only way of treating SCFE.

Most often, in situ fixation involves the insertion of a cannulated screw under fluoroscopic guidance. Performing surgery on an emergency versus elective basis, utilizing 1 versus 2 screws, utilizing a fracture table versus

From the Division of Pediatric Orthopaedics, Department of Orthopaedics, New York University, Hospital for Joint Diseases, New York, NY.

The authors declare no conflicts of interest.

Reprints: Dinesh P. Thawrani, MD, FACS, Division of Pediatric Orthopaedics, Department of Orthopaedics, New York University, Hospital for Joint Diseases, 301 E 17th street, New York, NY 10003. E-mail: dr_dineshthawrani@yahoo.co.in.

a radiolucent table, and prophylactic pinning of the contralateral hip are some variables on which considerable controversy still exists.

To understand the current management protocol utilized by pediatric orthopaedic surgeons in the treatment of SCFE we presented a survey to all of the members of the Pediatric Orthopaedic Society of North America (POSNA). The purpose of this survey was 2-fold, to determine the current pattern of treating SCFE among pediatric orthopaedic surgeons and to investigate the variables on which POSNA members disagree with the conventional in situ fixation method.

METHODS

A cross-sectional survey design was utilized. Approval was obtained from the evidence-based medicine committee of the POSNA. An electronic survey was then created on Survey Monkey and distributed to all POSNA members by email. A reminder was sent by email to all POSNA members 2 weeks after the initial contact. The survey included questions in 5 categories: surgeon's demographics, preoperative evaluation, operative plan, perioperative protocol, and postoperative plan. All 3 widely used classification systems (according to the onset of symptoms, morphologic appearance on regular x rays, and function) were incorporated into the survey to ensure that maximum responses would be obtained, as surgeons may be using either or all of these classification systems in their practice. On the basis of onset of symptoms SCFE was classified into acute (< 3 wk history of symptoms), acute-on-chronic (> 3 wk history of symptoms with a sudden exacerbation of pain and inability to walk), and chronic (> 3 wk history of symptoms). Morphologic classification depends on the degree of displacement of the femoral epiphysis relative to the neck: mild slip (head-shaft angle differs by < 30 degrees), moderate slip (angle between 30 and 60 degrees), and severe slip (angle > 60 degrees). Functional classification was according to the patient's ability to bear weight: unstable slip (one in which the child is in such severe pain that he/she cannot walk even with crutches) and stable slip (the child is able to walk with or without crutches).

Statistical Methods

For all of the questions, the frequency and percentage of each response was calculated for the sample as a whole. Additional analyses were performed with the respondents divided into 3 different dichotomized groupings. The median was determined for the number of years in practice (median = 17.0) and the number of SCFEs treated per year (median = 10.0). The respondents were divided into groups on the basis of the type of practice (academic vs. private), number of years in practice ($\leq$15 vs. >15 y), and number of SCFEs treated per year (< 10 vs. $\geq$ 10). For the number of years in practice, 15 years was chosen as the dividing point to enable comparison with the results from a previous study.[10] The sample was still divided into relatively equal-sized groups (47% and 53%).

The t test for independent samples was used to compare the groups for number of years in practice and number of SCFEs treated per year. The χ^2 test was used for comparing the remaining variables. For all analyses, $P < 0.05$ was considered statistically significant.

RESULTS

Of 990 POSNA members, 277 (28%) responded to the survey. Of 277 responders, 259 (93.5%) were from North America. The data were analyzed to determine the specifics of surgeons' practice, such as, type of practice [academic (n = 181) or private (n = 51)], years in the practice [$\leq$15 (n = 124) or >15 y (n = 140)], and the number of SCFEs that the surgeon is treating each year [< 10 (n = 129) or $\geq$ 10 (n = 136)]. Analysis was then carried forward for the particulars of treatment protocol followed by the surgeons in each group.

Type of Practice: Academic (n = 181) Versus Private (n = 51)

Seventy-eight percent of total respondents are in academic practice. The mean number of years in practice (16.2 ± 10.7 vs. 17.2 ± 8.5; $P = 0.5$) and SCFEs treated in a year (10.2 ± 6.4 vs. 10.0 ± 7.1; $P = 0.8$) are similar between the academic and private practice groups (Tables 1–4).

Preoperative Evaluation

In addition to anteroposterior pelvis x-ray of both hips, the majority of surgeons (77% academic and 87% private practice) preferred to obtain frog-leg lateral view of both hips and only a few requested cross-table lateral views (Table 1). Surgeons mentioned that they obtain cross-table lateral views only when the slip is unstable or the frog-leg lateral position is painful. Further imaging studies like magnetic resonance imaging (MRI) (27.3% vs. 30.6%), computed tomography (CT) scan (16.9% vs. 10.4%), and bone scan (4.5% vs. 10.4%) are requested by a small percentage of respondents, with no significant difference between the groups. Most common reasons for obtaining MRI were to look for preslip, clinical suspicion of slip in the setting of normal radiographs, or to assess viability of the femoral head in unstable slips when the patient is presenting late. The reason for bone scan was also to assess head vascularity in unstable slips. A CT scan was ordered by surgeons for severe slips to assess the precise anatomy for acute osteotomy.

Operative Plan

For unstable severe slips, surgeons in academic practice would acutely reduce the slip by the SHD approach more frequently than those in private practice (35.7% vs. 14.9%; $P = 0.02$). Conversely, surgeons in private practice would more frequently perform in situ fixation after manual reduction than those in an academic setting, for severe unstable slips (29.8% vs. 14.9%; $P = 0.02$) (Table 2).

TABLE 1. Preoperative Evaluation of Patients With SCFE Depending on the Type of Practice of the Respondents (Academic, n = 181 vs. Private, n = 51)

	Academic [n (%)]	Private [n (%)]	*P*
Anteroposterior pelvis x-ray +			
Frog-leg lateral view	131 (76.6)	41 (87.2)	
Cross-table lateral of involved side	11 (6.4)	3 (6.4)	0.189
Cross-table lateral of both sides	29 (17)	3 (6.4)	
Specific tests			
MRI	48 (27.3)	15 (30.6)	0.645
CT scan	30 (16.9)	5 (10.4)	0.268
Bone scan	8 (4.5)	5 (10.4)	0.120
Classification			
Acute/acute-on-chronic/chronic	0	0	
Unstable/stable	85 (49.4)	16 (34.8)	0.077
Both	87 (50.6)	30 (65.2)	

Discrepancy in the total value of each row at some places is because a few respondents did not answer all of the questions of the survey.
CT indicates computed tomography; MRI, magnetic resonance imaging; SCFE, slipped capital femoral epiphysis.

Perioperative Protocol

Radiolucent operating room (OR) table is used significantly more frequently in academic practice for both stable (50.6% vs. 29.8%; $P = 0.01$) and unstable (39.6% vs. 15.2%; $P = 0.002$) SCFE (Table 3). Surgeons in private practice more frequently use fracture table for both stable ($P = 0.011$) and unstable ($P = 0.002$) SCFE. Fully threaded cannulated screws (44.4% vs. 27.1%; $P = 0.03$), open capsulotomy for capsular decompression as opposed to needle aspiration (63.9% vs. 32.4%; $P = 0.001$), and contralateral pinning (79% vs. 58.7%; $P = 0.005$) are significantly more frequent in academic practice than private. Surgeons doing contralateral pinning at the same time reported that they prefer to do it for patients 10 years of age or younger at the time of first slip, with open triradiate cartilage, with underlying endocrinopathy, or with an unreliable family for the follow-up.

Postoperative Plan

Surgeons in academic practice perform postoperative MRI more frequently than those in private (15.5% vs. 3.9%; $P = 0.03$). MRI is performed particularly in cases with high suspicion for AVN, persistent postoperative pain, or signs and symptoms of FAI. The use of postoperative CT is similar in both academic and private settings (10.5% vs. 9.8%). CT scans are more frequently performed for planning of reconstructive osteotomies, to verify fusion of physis, or in doubtful cases in which pin penetration in the joint is suspected (Table 4).

Years of Practice: ≤15 y (n = 124) Versus >15 y (n = 140)

The mean number of SCFEs performed per year (10.5 ± 8.1 vs. 10.2 ± 6.3; $P = 0.731$) and number of surgeons in academic (79.6% vs. 77.1%; $P = 0.647$) or private (20.4% vs. 22.9%; $P = 0.647$) practice are not significantly different between the groups.

Preoperative Evaluation

Surgeons with >15 years of practice do cross-table lateral view of both hips more frequently than those with ≤15 years of practice (8.5% vs. 17.3%; $P = 0.042$). Surgeons with ≤15 years of practice perform preoperative MRI more frequently (36.1% vs. 20.6%; $P = 0.006$) (Table 5).

Operative Plan

For stable moderate slips, in situ fixation with no manipulation is more frequent among surgeons with >15 years of experience, whereas in situ fixation with positioning the leg in internal rotation is more frequent among surgeons ≤15 years in practice ($P = 0.031$). For stable severe slips, surgeons ≤15 years in practice do acute reduction using SHD more frequently than those >15 years in their practice, who do acute osteotomies more frequently than those ≤15 years in practice ($P = 0.004$). For unstable moderate slips, surgeons ≤15 years in practice do acute reduction by the SHD approach more frequently than surgeons >15 years in practice ($P = 0.049$) (Table 6).

Perioperative Protocol

Capsular decompression using an open capsulotomy approach was more frequent among surgeons ≤15 years in practice than surgeons >15 years in practice who preferred to perform capsular decompression by needle aspiration (69.3% vs. 48.3%; $P = 0.017$) (Table 7).

Postoperative Plan

There was no statistical difference between the groups in postoperative care (Table 8).

Number of SCFEs Treated Per Year: <10 (n = 129) Versus ≥10 (n = 136)

The mean number of years of practice (16.2 ± 10.1 vs. 16.5 ± 9.6; $P = 0.841$) and surgeons in academic (77.1% vs. 81%; $P = 0.464$) or private (22.9% vs. 19%; $P = 0.464$) practice are not significantly different between the groups.

TABLE 2. Operative Plan for the Treatment of SCFE Depending on the Type of Practice of the Respondents

	Academic [n (%)]	Private [n (%)]	*P*
Timing of surgery			
Stable			
Emergent (middle of the night)	0	0	
Urgent (within 8 h)	35 (20.2)	7 (14.9)	0.409
Elective	138 (79.8)	40 (85.1)	
Unstable			
Emergent (middle of the night)	45 (26)	17 (35.4)	
Urgent (within 8 h)	118 (68.2)	29 (60.4)	0.426
Elective	10 (5.8)	2 (4.2)	
Type of surgery			
Stable mild			
In situ fixation with no manipulation	119 (72.1)	36 (76.6)	
In situ fixation after positioning leg in internal rotation	46 (76.6)	11 (23.4)	
In situ fixation after manual reduction	0	0	0.542
Acute osteotomy	0	0	
Surgical hip dislocation and open reduction	0	0	
Stable moderate			
In situ fixation with no manipulation	102 (64.6)	29 (63)	
In situ fixation after positioning leg in internal rotation	56 (35.4)	17 (37)	
In situ fixation after manual reduction	0	0	0.851
Acute osteotomy	0	0	
Surgical hip dislocation and open reduction	0	0	
Stable severe			
In situ fixation with no manipulation	75 (48.4)	21 (45.7)	
In situ fixation after positioning leg in internal rotation	48 (31)	21 (45.7)	
In situ fixation after manual reduction	0	0	0.143
Acute osteotomy	10 (6.5)	2 (4.3)	
Surgical hip dislocation and open reduction	22 (14.2)	2 (4.3)	
Unstable mild			
In situ fixation with no manipulation	44 (26.5)	12 (25)	
In situ fixation after positioning leg in internal rotation	97 (58.4)	29 (60.4)	
In situ fixation after manual reduction	13 (7.8)	5 (10.4)	0.829
Acute osteotomy	0	0	
Surgical hip dislocation and open reduction	12 (7.2)	2 (4.2)	
Unstable moderate			
In situ fixation with no manipulation	13 (7.9)	5 (10.4)	
In situ fixation after positioning leg in internal rotation	90 (54.9)	31 (64.6)	0.081
In situ fixation after manual reduction	19 (11.6)	8 (16.7)	
Acute osteotomy	0	0	
Surgical hip dislocation and open reduction	42 (25.6)	4 (8.3)	
Unstable severe			
In situ fixation with no manipulation	**6 (3.6)**	**2 (4.3)**	
In situ fixation after positioning leg in internal rotation	**77 (45.8)**	**24 (51.1)**	
In situ fixation after manual reduction	**25 (14.9)**	**14 (29.8)**	**0.020**
Acute osteotomy	**0**	**0**	
Surgical hip dislocation and open reduction	**60 (35.7)**	**7 (14.9)**	

Discrepancy in the total value of each row at some places is because a few respondents did not answer all of the questions of the survey.
Statistically significant values are in bold.
SCFE indicates slipped capital femoral epiphysis.

Preoperative Evaluation

There was no statistical difference between the groups in preoperative evaluation (Table 9).

Operative Plan

The incidence of acute reduction by the SHD approach for stable severe (12.6% vs. 15.6%; $P = 0.073$), unstable mild (5% vs. 7.3%; $P = 0.739$), or unstable moderate (16.2% vs. 27.8%; $P = 0.153$) did not change with the number of slips treated each year. However, for unstable severe SCFE, surgeons performing ≥ 10/y do the SHD approach (38.6%) more frequently than those performing < 10/y (26.1%, $P = 0.029$). At the same time, in situ fixation after manual reduction is more frequent among surgeons performing < 10/y (21.8% vs. 11.8%; $P = 0.029$) (Table 10).

Perioperative Protocol

For stable SCFE, a radiolucent OR table is more frequently utilized by surgeons performing ≥ 10/y (54.3%) than those performing < 10/y (45.7%, $P = 0.010$), who more frequently use a fracture table. However, for unstable SCFE, both groups use a fracture table (65.5% vs. 64.8%) more frequently than a radiolucent OR table (34.5% vs. 35.2%). Surgeons performing ≥ 10/y utilize 7.5 mm of screw more frequently than those performing < 10/y

TABLE 3. Perioperative Protocol in the Treatment of Patients With SCFE Depending on the Type of Practice of the Respondents

	Academic [n (%)]	Private [n (%)]	*P*
Stable			
Fracture table	**84 (49.4)**	**33 (70.2)**	**0.011**
Radiolucent table	**86 (50.6)**	**14 (29.8)**	
Unstable			
Fracture table	**99 (60.4)**	**39 (84.8)**	**0.002**
Radiolucent table	**65 (39.6)**	**7 (15.2)**	
Cannulated screw			
Stainless steel	152 (88.4)	43 (89.6)	0.815
Titanium	20 (11.6)	5 (10.4)	
Screw threads			
Partial	**94 (55.6)**	**35 (72.9)**	**0.031**
Full	**75 (44.4)**	**13 (27.1)**	
Stable mild			
Size of screw: 6.5	79 (49.1)	17 (36.2)	0.119
7.5	82 (50.9)	30 (63.8)	
Stable moderate			
Size of screw: 6.5	78 (48.4)	18 (39.1)	0.264
7.5	83 (51.6)	28 (60.9)	
Stable severe			
Size of screw: 6.5	79 (50)	19 (40.4)	0.249
7.5	79 (50)	28 (59.6)	
Unstable mild			
Size of screw: 6.5	85 (53.1)	20 (43.5)	0.249
7.5	75 (46.9)	26 (56.5)	
Unstable moderate			
Size of screw: 6.5	87 (55.1)	22 (47.8)	0.386
7.5	71 (44.9)	24 (52.2)	
Unstable severe			
Size of Screw: 6.5	90 (56.6)	25 (53.2)	0.679
7.5	69 (43.4)	22 (46.8)	
Stable mild			
No. screws: 1	166 (98.8)	48 (100)	
2	0	0	
Stable moderate			
No. screws: 1	160 (96.4)	43 (91.5)	
2	0	0	
Stable severe			
No. screws: 1	141 (86)	39 (84.8)	0.838
2	23 (14)	7 (15.2)	
Unstable mild			
No. screws: 1	82 (50.3)	24 (52.2)	0.823
2	81 (49.7)	22 (47.8)	
Unstable moderate			
No. screws: 1	57 (33.9)	13 (27.7)	0.418
2	111 (66.1)	34 (72.3)	
Unstable severe			
No. screws: 1	39 (23.2)	10 (21.3)	0.780
2	129 (76.8)	37 (78.7)	
Vascular decompression			
Stable slip	2 (1.2)	2 (4.3)	
Unstable slip	134 (78.8)	37 (77.1)	0.796
Vascular decompression			
Needle decompression	**44 (36.1)**	**23 (67.6)**	**0.001**
Open arthrotomy	**78 (63.9)**	**11 (32.4)**	
Contralateral pinning			
Yes	**132 (79)**	**27 (58.7)**	**0.005**
No	**35 (21)**	**19 (41.3)**	

Discrepancy in the total value of each row at some places is because a few respondents did not answer all of the questions of the survey.
Statistically significant values are in bold.
SCFE indicates slipped capital femoral epiphysis.

(Table 11). Surgeons treating a higher number of SCFE also perform prophylactic contralateral pinning more frequently (78.9%) than those performing < 10/y (67.8%, $P = 0.048$).

TABLE 4. Postoperative Plan for Patients With SCFE Depending on the Type of Practice of the Respondents

	Academic [n (%)]	Private [n (%)]	*P*
Follow-up duration			
Skeletal maturity	120 (73.2)	32 (72.7)	
Beyond skeletal maturity	26 (15.9)	5 (11.4)	0.556
2-5 y after surgery	18 (11)	7 (15.9)	
Specific tests			
MRI	**28 (15.5)**	**2 (3.9)**	**0.030**
CT scan	19 (10.5)	5 (9.8)	0.886
Elective screw removal			
Yes	19 (11.4)	4 (8.5)	0.575
No	148 (88.6)	43 (91.5)	

Discrepancy in the total value of each row at some places is because a few respondents did not answer all of the questions of the survey.
Statistically significant values are in bold.
CT indicates computed tomography; MRI, magnetic resonance imaging; SCFE, slipped capital femoral epiphysis.

For unstable SCFE, capsular decompression is preferred in both groups (72.1% and 80.5%).

Postoperative Plan

Postoperative MRI (17.6% vs. 9.3%; $P = 0.048$) and CT scans (14.7% vs. 7%; $P = 0.044$) are more frequently utilized among surgeons treating a higher number of SCFEs per year (Table 12). However, elective removal of screw is more common among surgeons performing < 10 SCFEs per year (16.2% vs. 6.9%; $P = 0.021$).

Surgical Hip Dislocation and Open Reduction

Responses were further analyzed to determine the overall prevalence of SHD in the society. Among the respondents, 22.7% (63/277) reported that they routinely use the SHD technique in their practice. However, indications for using this technique varied and depended largely on the type of SCFE (stable vs. unstable) and severity of SCFE. Unstable severe slip is the most

TABLE 5. Preoperative Evaluation of Patients With SCFE Depending on the Years of Practice of the Respondents (≤15 y, n = 124 vs. >15 y, n = 140)

	≤15 y [n (%)]	> 15 y [n (%)]	*P*
Anteroposterior pelvis x-ray +			
Frog-leg lateral view	**102 (86.4)**	**98 (73.7)**	
Cross-table lateral of involved side	**6 (5.1)**	**12 (9)**	**0.042**
Cross-table lateral of both sides	**10 (8.5)**	**23 (17.3)**	
Specific tests			
MRI	**44 (36.1)**	**28 (20.6)**	**0.006**
CT scan	14 (11.4)	27 (20)	0.059
Bone scan	8 (6.6)	9 (6.6)	0.984
Classification			
Acute/acute-on-chronic/chronic	5 (4.1)	5 (3.7)	
Unstable/stable	51 (42.1)	59 (43.7)	0.960
Both	65 (53.7)	71 (52.6)	

Discrepancy in the total value of each row at some places is because a few respondents did not answer all of the questions of the survey.
Statistically significant values are in bold.
CT indicates computed tomography; MRI, magnetic resonance imaging; SCFE, slipped capital femoral epiphysis.

TABLE 6. Operative Plan for the Treatment of SCFE Depending on the Years of Practice of the Respondents

	≤15 y [n (%)]	> 15 y [n (%)]	*P*
Timing of surgery			
Stable			
Emergent (middle of the night)	0	0	
Urgent (within 8 h)	23 (19.3)	28 (21.1)	0.734
Elective	96 (80.7)	105 (78.9)	
Unstable			
Emergent (middle of the night)	36 (29.8)	30 (22.7)	
Urgent (within 8 h)	78 (64.5)	97 (73.5)	0.291
Elective	7 (5.8)	5 (3.8)	
Type of surgery			
Stable mild			
In situ fixation with no manipulation	80 (70.2)	99 (77.3)	
In situ fixation after positioning leg in internal rotation	34 (29.8)	29 (22.7)	
In situ fixation after manual reduction	0	0	0.205
Acute osteotomy	0	0	
Surgical hip dislocation and open reduction	0	0	
Stable moderate			
In situ fixation with no manipulation	**62 (57.9)**	**88 (71.5)**	
In situ fixation after positioning leg in internal rotation	**45 (42.1)**	**35 (28.5)**	
In situ fixation after manual reduction	**0**	**0**	**0.031**
Acute osteotomy	**0**	**0**	
Surgical hip dislocation and open reduction	**0**	**0**	
Stable severe			
In situ fixation with no manipulation	**45 (41.3)**	**64 (52.5)**	
In situ fixation after positioning leg in internal rotation	**40 (36.7)**	**37 (30.3)**	
In situ fixation after manual reduction	**0**	**0**	**0.004**
Acute osteotomy	**2 (1.8)**	**11 (9)**	
Surgical hip dislocation and open reduction	**22 (20.2)**	**10 (8.2)**	
Unstable mild			
In situ fixation with no manipulation	32 (28.1)	36 (28.6)	
In situ fixation after positioning leg in internal rotation	63 (55.3)	76 (60.3)	
In situ fixation after manual reduction	9 (7.9)	8 (6.3)	0.590
Acute osteotomy	0	0	
Surgical hip dislocation and open reduction	10 (8.8)	6 (4.8)	
Unstable moderate			
In situ fixation with no manipulation	**8 (7.0)**	**18 (14.2)**	
In situ fixation after positioning leg in internal rotation	**60 (52.6)**	**73 (57.5)**	
In situ fixation after manual reduction	**12 (10.5)**	**15 (11.8)**	**0.049**
Acute osteotomy	**0**	**0**	
Surgical hip dislocation and open reduction	**34 (29.8)**	**21 (16.5)**	
Unstable severe			
In situ fixation with no manipulation	3 (2.6)	9 (7.1)	
In situ fixation after positioning leg in internal rotation	50 (42.7)	63 (50)	
In situ fixation after manual reduction	22 (18.8)	18 (14.3)	0.170
Acute osteotomy	0	0	
Surgical hip dislocation and open reduction	42 (35.9)	36 (28.6)	

Discrepancy in the total value of each row at some places is because a few respondents did not answer all of the questions of the survey.
Statistically significant values are in bold.
SCFE indicates slipped capital femoral epiphysis.

common indication for the SHD approach (59/63). Unstable moderate (40/63) and stable severe (29/63) slips are other indications for performing SHD among respondents, with some also doing it for unstable mild (13/63) and stable moderate (5/63) SCFE. Further, surgeons utilizing SHD approach are predominantly in academic practice (26% academic vs. 9.8% private; $P = 0.014$) and are doing higher volume of SCFEs (≥ 10) per year (30.1% vs. 17.1%; $P = 0.012$). These surgeons also tend to be ≤ 15 years in their practice (28.2% vs. 18.6%; $P = 0.063$). In addition, 15 respondents (5.4%) mentioned that they would acutely open to reduce the slip but failed to select the type of open approach they would perform. There was no statistical difference in the outcomes when analysis was performed combining these 15 respondents with SHD or by keeping them as a separate group.

DISCUSSION

This study demonstrates that in situ fixation is no longer the only treatment option for SCFE. Surgeons are inclined to use newer surgical treatment methods, such as the SHD approach, to acutely reduce the slip. However, there is no distinct consensus among society members regarding the indications for SHD versus in situ fixation. Current treatment of SCFE varies significantly depending on the surgeon's type of practice, years in practice, and

TABLE 7. Perioperative Protocol in the Treatment of Patients With SCFE Depending on the Years of Practice of the Respondents

	≤15 y [n (%)]	> 15 y [n (%)]	*P*
Stable			
Fracture table	57 (49.1)	78 (58.6)	0.133
Radiolucent table	59 (50.9)	55 (41.4)	
Unstable			
Fracture table	65 (58.6)	91 (70.5)	0.052
Radiolucent table	46 (41.4)	38 (29.5)	
Cannulated screw			
Stainless steel	105 (88.2)	117 (88.6)	0.921
Titanium	14 (11.8)	15 (11.4)	
Screw threads			
Partial	69 (59.5)	81 (60.9)	0.819
Full	47 (40.5)	52 (39.1)	
Stable mild			
Size of screw: 6.5	51 (44.3)	60 (48.4)	0.532
7.5	64 (55.7)	64 (51.6)	
Stable moderate			
Size of screw: 6.5	51 (45.1)	59 (48)	0.663
7.5	62 (54.9)	64 (52)	
Stable severe			
Size of screw: 6.5	52 (46.8)	60 (48.8)	0.767
7.5	59 (53.2)	63 (51.2)	
Unstable mild			
Size of screw: 6.5	55 (50.5)	65 (51.6)	0.863
7.5	54 (49.5)	61 (48.4)	
Unstable moderate			
Size of screw: 6.5	59 (54.1)	63 (51.6)	0.705
7.5	50 (45.9)	59 (48.4)	
Unstable severe			
Size of screw: 6.5	63 (57.3)	65 (52.4)	0.457
7.5	47 (42.7)	59 (47.6)	
Stable mild			
No. screws: 1	115 (98.3)	130 (100)	
2	2 (1.7)	0	
Stable moderate			
No. screws: 1	109 (94.8)	123 (96.9)	
2	6 (5.2)	4 (3.1)	
Stable severe			
No. screws: 1	93 (83)	109 (86.5)	0.456
2	19 (17)	17 (13.5)	
Unstable mild			
No. screws: 1	61 (55)	65 (51.6)	0.604
2	50 (45)	61 (48.4)	
Unstable moderate			
No. screws: 1	43 (37.7)	40 (31)	0.271
2	71 (62.3)	89 (69)	
Unstable severe			
No. screws: 1	32 (28.1)	26 (20.2)	0.149
2	82 (71.9)	103 (79.8)	
Vascular decompression			
Stable slip	3 (2.6)	1 (0.8)	
Unstable slip	94 (80.3)	97 (73.5)	0.201
Vascular decompression			
Needle decompression	**27 (30.7)**	**42 (48.3)**	**0.017**
Open arthrotomy	**61 (69.3)**	**45 (51.7)**	
Contralateral pinning			
Yes	92 (79.3)	89 (69)	0.066
No	24 (20.7)	40 (31)	

Discrepancy in the total value of each row at some places is because a few respondents did not answer all of the questions of the survey.
Statistically significant values are in bold.
SCFE indicates slipped capital femoral epiphysis.

number treated per year. Surgeons in academic practice, surgeons with ≤15 years in practice, and surgeons treating a higher volume of SCFEs per year are more likely to use

TABLE 8. Postoperative Plan for Patients With SCFE Depending on the Years of Practice of the Respondents

	≤15 y [n (%)]	> 15 y [n (%)]	*P*
Follow-up duration			
Skeletal maturity	81 (73)	92 (73)	
Beyond skeletal maturity	17 (15.3)	21 (16.7)	0.918
2-5 y after surgery	13 (11.7)	13 (10.3)	
Specific tests			
MRI	17 (13.7)	19 (13.6)	0.974
CT scan	12 (9.7)	18 (12.9)	0.417
Elective screw removal			
Yes	10 (8.6)	16 (12.3)	0.348
No	106 (91.4)	114 (87.7)	

Discrepancy in the total value of each row at some places is because a few respondents did not answer all of the questions of the survey.
CT indicates computed tomography; MRI, magnetic resonance imaging; SCFE, slipped capital femoral epiphysis.

SHD. This is in contrast to the surgeons >15 years in practice who prefer to perform acute osteotomies for severe slips more frequently than surgeons ≤15 years in practice.

In 1981, Boyer and colleagues reported their long-term follow-up results of treating SCFE by various methods. They concluded that in situ fixation without manipulation gives better results than any other technique.[11] The technique carries various advantages, including: easy to perform, minimal blood loss, small surgical scar, brief hospital stay, early weight bearing, reliable outcomes, and fewer complications.[11–16] Over the years, in situ fixation became the treatment of choice for all types of SCFE. In 1997, Goodman et al[17] reported from their study of a large series of osteological collection of hip joints that anterior flattening of the acetabulum from direct impaction of abnormal femoral head neck morphology after a slip eventually leads to global osteoarthrosis. Rab[18] came to the same conclusion from his 3-dimensional volume/surface computerized models that

TABLE 9. Preoperative Evaluation of Patients With SCFE Depending on the Number Treated Per Year by the Respondent (<10/y, n=129 vs. ≥10/y, n=136)

	< 10/y [n (%)]	≥ 10/y [n (%)]	*P*
Anteroposterior pelvis x-ray +			
Frog-leg lateral view	99 (79.8)	101 (78.9)	
Cross-table lateral of involved side	10 (8.1)	8 (6.3)	0.723
Cross-table lateral of both sides	15 (12.1)	19 (14.8)	
Specific tests			
MRI	29 (23.4)	44 (32.4)	0.108
CT scan	20 (16)	21 (15.6)	0.922
Bone scan	8 (6.4)	8 (5.9)	0.874
Classification			
Acute/acute-on-chronic/chronic	8 (6.5)	2 (1.5)	
Unstable/stable	48 (38.7)	61 (45.5)	0.089
Both	68 (54.8)	71 (53)	

Discrepancy in the total value of each row at some places is because a few respondents did not answer all of the questions of the survey.
CT indicates computed tomography; MRI, magnetic resonance imaging; SCFE, slipped capital femoral epiphysis.

TABLE 10. Operative Plan for the Treatment of SCFE Depending on the Number Treated Per Year by the Respondent

	< 10/y [n (%)]	≥ 10/y [n (%)]	*P*
Timing of surgery			
Stable			
Emergent (middle of the night)	0	0	
Urgent (within 8 h)	29 (23.6)	22 (16.9)	0.187
Elective	94 (76.4)	108 (83.1)	
Unstable			
Emergent (middle of the night)	39 (31.7)	29 (22)	
Urgent (within 8 h)	75 (61)	98 (74.2)	0.069
Elective	9 (7.3)	5 (3.8)	
Type of surgery			
Stable mild			
In situ fixation with no manipulation	82 (69.5)	36 (30.5)	
In situ fixation after positioning leg in internal rotation	36 (30.5)	27 (21.4)	
In situ fixation after manual reduction	0	0	0.105
Acute osteotomy	0	0	
Surgical hip dislocation and open reduction	0	0	
Stable moderate			
In situ fixation with no manipulation	66 (58.4)	84 (70.6)	
In situ fixation after positioning leg in internal rotation	47 (41.6)	35 (29.4)	
In situ fixation after manual reduction	0	0	0.052
Acute osteotomy	0	0	
Surgical hip dislocation and open reduction	0	0	
Stable severe			
In situ fixation with no manipulation	46 (41.4)	63 (51.6)	
In situ fixation after positioning leg in internal rotation	46 (41.4)	31 (25.4)	
In situ fixation after manual reduction	0	0	0.073
Acute osteotomy	5 (4.5)	9 (7.4)	
Surgical hip dislocation and open reduction	14 (12.6)	19 (15.6)	
Unstable mild			
In situ fixation with no manipulation	36 (30.3)	35 (28.5)	
In situ fixation after positioning leg in internal rotation	67 (56.3)	72 (58.5)	
In situ fixation after manual reduction	10 (8.4)	7 (5.7)	0.739
Acute osteotomy	0	0	
Surgical hip dislocation and open reduction	6 (5)	9 (7.3)	
Unstable moderate			
In situ fixation with no manipulation	15 (12.8)	12 (9.5)	
In situ fixation after positioning leg in internal rotation	65 (55.6)	68 (54)	
In situ fixation after manual reduction	18 (15.4)	11 (8.7)	0.153
Acute osteotomy	0	0	
Surgical hip dislocation and open reduction	19 (16.2)	35 (27.8)	
Unstable severe			
In situ fixation with no manipulation	**9 (7.6)**	**4 (3.1)**	
In situ fixation after positioning leg in internal rotation	**53 (44.5)**	**59 (46.5)**	
In situ fixation after manual reduction	**26 (21.8)**	**15 (11.8)**	**0.029**
Acute osteotomy	**0**	**0**	
Surgical hip dislocation and open reduction	**31 (26.1)**	**49 (38.6)**	

Discrepancy in the total value of each row at some places is because a few respondents did not answer all of the questions of the survey.
Statistically significant values are in bold.
SCFE indicates slipped capital femoral epiphysis.

anterior impingement from prominent metaphysis can lead to acetabular damage. Leunig and colleagues confirmed these findings intraoperatively during open treatment of chronic slips. They reported that prominent anterior femoral metaphysis was the reason for adjacent acetabular cartilage damage and early osteoarthrosis.[3] These findings encouraged surgeons to look for an alternative technique for the treatment of SCFE to obtain anatomic reduction and thus to hopefully avoid subsequent residual femoral head neck junction pathology.

Over the last decade, as more surgeons are receiving training in SHD, in situ pinning is no longer the only technique of treating SCFE. There are several case series reporting encouraging results of using the SHD technique in the treatment of SCFE.[8,19,20] In a previous 2004-2005 SCFE survey, Mooney et al[10] reported that only 3% of surgeons performed open reduction of the hip while there was no description of using the SHD approach at all. In situ fixation was the only technique utilized by surgeons at that time. The current survey shows that nearly a quarter of the respondents reported that they keep the SHD approach in their armamentarium in treating SCFE. This is a shift of surgical technique in the last decade. The literature supports 2 specific indications for anatomic reduction of the slip by SDH: acute/unstable SCFE and chronic SCFE (with open physis).[21] The

TABLE 11. Perioperative Protocol in the Treatment of Patients With SCFE Depending on the Number Treated Per Year by the Respondents

	< 10/y [n (%)]	≥ 10/y [n (%)]	*P*
Stable			
Fracture table	**75 (62)**	**59 (45.7)**	**0.010**
Radiolucent table	**46 (38)**	**70 (54.3)**	
Unstable			
Fracture table	76 (65.5)	81 (64.8)	0.907
Radiolucent table	40 (34.5)	44 (35.2)	
Cannulated screw			
Stainless steel	103 (85.1)	119 (90.8)	0.162
Titanium	18 (14.9)	12 (9.2)	
Screw threads			
Partial	73 (60.8)	74 (56.9)	0.530
Full	47 (39.2)	56 (43.1)	
stable mild			
Size of screw: 6.5	**65 (54.6)**	**46 (38)**	**0.010**
7.5	**54 (45.4)**	**75 (62)**	
Stable moderate			
Size of screw: 6.5	**64 (54.2)**	**46 (38.7)**	**0.016**
7.5	**54 (45.8)**	**73 (61.3)**	
Stable severe			
Size of screw: 6.5	**65 (55.1)**	**47 (40.2)**	**0.022**
7.5	**53 (44.9)**	**70 (59.8)**	
Unstable mild			
Size of screw: 6.5	68 (56.7)	52 (44.8)	0.069
7.5	52 (43.3)	64 (55.2)	
Unstable moderate			
Size of screw: 6.5	**69 (59)**	**53 (46.1)**	**0.049**
7.5	**48 (41)**	**62 (53.9)**	
Unstable severe			
Size of screw: 6.5	71 (60.2)	56 (47.9)	0.058
7.5	47 (39.8)	61 (52.1)	
stable mild			
No. screws: 1	120 (99.2)	126 (99.2)	
2	1 (0.8)	1 (0.8)	
Stable moderate			
No. screws: 1	114 (95)	118 (95.9)	0.726
2	6 (5)	5 (4.1)	
Stable severe			
No. screws: 1	96 (80.7)	108 (88.5)	0.091
2	23 (19.3)	14 (11.5)	
Unstable mild			
No. screws: 1	63 (54.3)	62 (50.8)	0.590
2	53 (45.7)	60 (49.2)	
Unstable moderate			
No. screws: 1	35 (29.2)	46 (37.1)	0.188
2	85 (70.8)	78 (62.9)	
Unstable severe			
No. screws: 1	24 (20)	34 (27.4)	0.173
2	96 (80)	90 (72.6)	
Vascular decompression			
Stable slip	4 (3.3)	0	
Unstable slip	88 (72.1)	103 (80.5)	0.121
Vascular decompression			
Needle decompression	31 (40.3)	38 (38.8)	0.842
Open arthrotomy	46 (59.7)	60 (61.2)	
Contralateral pinning			
Yes	**80 (67.8)**	**101 (78.9)**	**0.048**
No	**38 (32.2)**	**27 (21.1)**	

Discrepancy in the total value of each row at some places is because a few respondents did not answer all of the questions of the survey.

Statistically significant values are in bold.

SCFE indicates slipped capital femoral epiphysis.

TABLE 12. Postoperative Plan for Patients With SCFE Depending on the Number Treated per Year by the Respondents

	< 10/y [n (%)]	≥ 10/y [n (%)]	*P*
Follow-up duration			
Skeletal maturity	86 (76.8)	87 (69.6)	
Beyond skeletal maturity	14 (12.5)	23 (18.4)	0.402
2-5 y after surgery	12 (10.7)	15 (12)	
Specific tests			
MRI	**12 (9.3)**	**24 (17.6)**	**0.048**
CT scan	**9 (7)**	**20 (14.7)**	**0.044**
Elective screw removal			
Yes	**19 (16.2)**	**9 (6.9)**	**0.021**
No	**98 (83.8)**	**121 (93.1)**	

Discrepancy in the total value of each row at some places is because a few respondents did not answer all of the questions of the survey.

Statistically significant values are in bold.

CT indicates computed tomography; MRI, magnetic resonance imaging; SCFE, slipped capital femoral epiphysis.

current survey shows that unstable moderate and severe slips are the most widely used indications for the SHD approach among POSNA members. Half of the surgeons performing SHD also reported that they would do it for severe stable slips. It is important to cite here that in contrast, a recent study by Alves et al,[22] a retrospective case-control study on 12 patients shows that open reduction and internal fixation by means of SHD (n = 6) does not decrease the rate of AVN when compared with closed reduction and percutaneous pinning (n = 6) performed for unstable SCFE.

Osteonecrosis of the femoral head is the most significant complication of the unstable slip. The rate of osteonecrosis after an unstable slip may vary between 3% and 58%, in contrast to 0% for stable slips.[4–7] In situ fixation with no attempt for reduction has been reported to show minimal complications. Incidence of osteonecrosis has been reported to increase with complete or partial reduction of unstable slips.[4,11] Risk factors for the development of osteonecrosis are severity of slip,[4,7,13] complete or partial reduction/manual reduction,[4,11] multiple pins,[4] and female sex.[7] Despite this, between 10% and 20% POSNA members reported that they prefer to do manual reduction before in situ pinning for moderate to severe unstable slips. The current survey also reveals that in situ fixation after positioning the leg in internal rotation is practiced by almost half of the POSNA members for unstable slips.

Increased intracapsular pressure has also been a postulated reason for osteonecrosis. However, its role has been studied only in cases of femoral neck fracture and not in SCFE.[23] Nonetheless, the current survey shows that majority of surgeons (nearly 77%) are doing capsular decompression in unstable slips. Nearly 3% reported that they will do it in all slips irrespective of its stability and 20% would not do for any slip. This is a shift in SCFE treatment over the last decade. The previous SCFE survey reported only 35% responses in favor of doing decompression in unstable slips.[10] Further, the current survey shows that surgeons in academic practice do open capsulotomy more frequently than those in private who perform needle aspiration to decompress the capsule.

In situ fixation using a radiolucent table versus fracture table is another controversial topic in the literature. A recent study by Mohammed et al[24] reported a significantly lower dose of radiation exposure on a radiolucent table as opposed to a fracture table. This is a significant finding as children are more sensitive to radiation exposure. Blasier et al[25] reported that use of a radiolucent table significantly reduces operating time as compared with the use of a fracture table for in situ fixation of SCFE. Radiolucent table for in situ fixation of SCFE has been reported as equally reliable by several studies.[25–27] The current survey shows a significant variation in the membership for the use of type of the table. Surgeons in private practice use fracture tables significantly more frequently than those in academic practice, for both stable and unstable slips.

One screw for in situ fixation of SCFE is considered as adequate and reliable in several clinical studies.[12,14,15,28] Biomechanical studies also show no additional gain of using 2 screws over 1.[29] The current survey reveals no controversy in the membership with regard to the number of screws to fix a stable slip. More than 90% of surgeons agree to the use of only 1 screw for a stable slip. However, disagreement exists in the number of screws used for unstable slips. There were equal numbers of responses for the use of 1 and 2 screws for an unstable mild slip. Number of screws increases with the severity of unstable slips. Almost three quarters use 2 screws for unstable severe slips.

Castro et al[30] concluded from a literature review of 325 studies that despite a higher risk for contralateral slip the standard of care is to have close clinical and radiographic follow-up of the asymptomatic contralateral hip for around 13 ± 1 months. The decision model created by Schultz et al[31] shows that prophylactic contralateral side pinning is beneficial in the long-term outcome for that hip. Riad et al[32] recommended doing prophylactic pinning of the contralateral side if the chronologic age of a female patient is below 10 years and that of a male patient is below 12 years at the time of initial slip. The current POSNA survey shows that prophylactic contralateral pinning is more frequent in the academic setting and among surgeons doing >10 cases per year. Surgeons also reported that they do contralateral pinning under certain circumstances, such as, patients with underlying metabolic or endocrine disorders, unreliable family for follow-up, open triradiate cartilage, age below 10 years, or if the modified Oxford score[33] is low showing significant amount of growth left.

There are certain aspects on which society members show wide agreement. Anteroposterior and frog-leg lateral views with consideration of cross-table lateral view for unstable or painful hip is the most common modality for the initial evaluation of SCFE in the society. Some other points of agreement among surgeons are: use of MRI or bone scan for hips with a clinical suspicion of a slip with a normal radiograph or for hips in which head viability is in question; elective treatment of stable slips while urgent to emergent for unstable slips; cannulated stainless steel screw is utilized by majority of surgeons as opposed to titanium screw; 1 screw is more frequently used for stable slips; in situ fixation method for stable slip without manipulation or after positioning the hip in internal rotation; and majority of surgeons prefer to follow patients up to their skeletal maturity.

Most surgeons reported that they use both classification systems: acute/acute-on-chronic/chronic as well as stable versus unstable. The most widely used classification system among the membership is stable versus unstable, which depends on physeal stability.[5] According to the actual definition by Loder and colleagues, an unstable slip is one in which the child is in such severe pain that he/she cannot walk even with crutches. In contrast, if the child is able to walk with or without crutches the slip is stable. It is difficult to ascertain in a survey whether surgeons are following the true definition of stable and unstable slips. This is a limitation of the study.

Elective removal of screws is indicated by only 11% of respondents. Incidence of elective removal of the screw has not changed over the years. It was the same (11.6%) in the previous survey conducted by Mooney et al.[10]

The current survey has several limitations. The first limitation is that only 28% of the POSNA members responded. This might be influenced by the fact that some of the POSNA members may not be actively treating SCFEs or some are retired and therefore do not feel comfortable responding to the survey. However, it is worth noting that from statistical analysis to get 95% confidence level with ± 5% margin of error for the survey population of 1000 we need minimum 278 (27.8%) responses. Therefore, it is still reasonable to analyze and interpret the data from the current survey. Second, this study is also subject to sampling error as the survey was provided to only POSNA members, assuming that they are treating SCFE more often than general orthopaedic surgeons in the community. Third limitation is the questionnaire itself; it is assumed that surgeons follow true definitions of some common terms like "stable" and "unstable" SCFE as stated above. The fourth limitation is that the survey lacks any specific inclusion or exclusion criteria such as any specific point that would modify the treatment such as patient age, sex, or endocrinopathies. To incorporate every detail in the survey is difficult, may create an excessively long survey, and therefore increases chances of incomplete responses. Thus, every attempt was made to keep the survey to the most common and relevant points. However, we provided extra space at the end of each set of questions to obtain information or particular remarks if surgeons change the specified treatment or technique in any specific patient or any specific circumstances. We did receive reasonable number of comments in these and included in the manuscript at relevant places.

Control over these facts is beyond the limits of this survey. Despite these limitations, the authors believe that findings of this survey are worthy to be shared with the society, as the survey reflects the practice of treating SCFE that exist in the real world. This survey also

revealed the fact that the treatment of SCFE is changing rapidly and there are many controversial areas on which the membership disagrees.

In conclusion, current treatment of SCFE varies significantly depending on the surgeon's type of practice, years in practice, and volume of practice. Given the lack of sufficient literature to support the SHD technique, we recommend performing a prospective multicenter study that can help to precisely define and evidently support indications for different treatment approaches and at the same time help to establish evidence-based guidelines for the management of SCFE.

REFERENCES

1. Abraham E, Gonzalez MH, Pratap S, et al. Clinical implications of anatomical wear characteristics in slipped capital femoral epiphysis and primary osteoarthritis. *J Pediatr Orthop*. 2007;27:788–795.
2. Ganz R, Leunig M, Leunig-Ganz K, et al. The etiology of osteoarthritis of the hip: an integrated mechanical concept. *Clin Orthop Relat Res*. 2008;466:264–272.
3. Leunig M, Casillas MM, Hamlet M, et al. Slipped capital femoral epiphysis: early mechanical damage to the acetabular cartilage by a prominent femoral metaphysis. *Acta Orthop Scand*. 2000;71: 370–375.
4. Tokmakova KP, Stanton RP, Mason DE. Factors influencing the development of osteonecrosis in patients treated for slipped capital femoral epiphysis. *J Bone Joint Surg Am*. 2003;85-A:798–801.
5. Loder RT, Richard BS, Shapiro PS, et al. Acute slipped capital femoral epiphysis: the importance of physeal stability. *J Bone Joint Surg Am*. 1993;75:1134–1140.
6. Kennedy JG, Hresko MT, Kasser JR, et al. Osteonecrosis of the femoral head associated with slipped capital femoral epiphysis. *J Pediatr Orthop*. 2001;21:189–193.
7. Palocaren T, Holmes L, Rogers K, et al. Outcome of in situ pinning in patients with unstable slipped capital femoral epiphysis: assessment of risk factors associated with avascular necrosis. *J Pediatr Orthop*. 2010;30:31–36.
8. Ganz R, Gill TJ, Gautier E, et al. Surgical dislocation of the adult hip a technique with full access to the femoral head and acetabulum without the risk of avascular necrosis. *J Bone Joint Surg Br*. 2001; 83:1119–1124.
9. Leunig M, Horowitz K, Manner H, et al. In situ pinning with arthroscopic osteoplasty for mild SCFE: a preliminary technical report. *Clin Orthop Relat Res*. 2010;468:3160–3167.
10. Mooney JF III, Sanders JO, Browne RH, et al. Management of unstable/acute slipped capital femoral epiphysis: results of a survey of the POSNA membership. *J Pediatr Orthop*. 2005;25: 162–166.
11. Boyer DW, Mickelson MR, Ponseti IV. Slipped capital femoral epiphysis. Long-term follow-up study of one hundred and twenty-one patients. *J Bone Joint Surg Am*. 1981;63:85–95.
12. Aronson DD, Carlson WE. Slipped capital femoral epiphysis. A prospective study of fixation with a single screw. *J Bone Joint Surg Am*. 1992;74:810–819.
13. Rattey T, Piehl F, Wright JG. Acute slipped capital femoral epiphysis. Review of outcomes and rates of avascular necrosis. *J Bone Joint Surg Am*. 1996;78:398–402.
14. Mulgrew E, Wells-Cole S, Ali F, et al. Single screw fixation in stable and unstable slipped upper femoral epiphysis. *J Pediatr Orthop B*. 2011;20:147–151.
15. Goodman WW, Johnson JT, Robertson WW Jr. Single screw fixation for acute and acute-on-chronic slipped capital femoral epiphysis. *Clin Orthop Relat Res*. 1996;322:86–90.
16. Bellemans J, Fabry G, Molenaers G, et al. Slipped capital femoral epiphysis: a long-term follow-up, with special emphasis on the capacities for remodeling. *J Pediatr Orthop B*. 1996;5:151–157.
17. Goodman DA, Feighan JE, Smith AD, et al. Subclinical slipped capital femoral epiphysis. Relationship to osteoarthrosis of the hip. *J Bone Joint Surg Am*. 1997;79:1489–1497.
18. Rab GT. The geometry of slipped capital femoral epiphysis: implications for movement, impingement, and corrective osteotomy. *J Pediatr Orthop*. 1999;19:419–424.
19. Slongo T, Kakaty D, Krause F, et al. Treatment of slipped capital femoral epiphysis with a modified Dunn procedure. *J Bone Joint Surg Am*. 2010;92:2898–2908.
20. Huber H, Dora C, Ramseier LE, et al. Adolescent slipped capital femoral epiphysis treated by a modified Dunn osteotomy with surgical hip dislocation. *J Bone Joint Surg Br*. 2011;93: 833–838.
21. Leunig M, Slongo T, Kleinschmidt M, et al. Subcapital correction osteotomy in slipped capital femoral epiphysis by means of surgical hip dislocation. *Oper Orthop Traumatol*. 2007;19:389–410.
22. Alves C, Steele M, Narayanan U, et al. Open reduction and internal fixation of unstable slipped capital femoral epiphysis by means of surgical dislocation does not decrease the rate of avascular necrosis: a preliminary study. *J Child Orthop*. 2012;6:277–283.
23. Ng GP, Cole WG. Effect of early hip decompression on the frequency of avascular necrosis in children with fractures of the neck of the femur. *Injury*. 1996;27:419–421.
24. Mohammed R, Johnson K, Bache E. Radiation exposure during in-situ pinning of slipped capital femoral epiphysis hips: does the patient positioning matter? *J Pediatr Orthop B*. 2010;19:333–336.
25. Blasier RD, Ramsey JR, White RR. Comparison of radiolucent and fracture tables in the treatment of slipped capital femoral epiphysis. *J Pediatr Orthop*. 2004;24:642–644.
26. Carney BT, Talwalkar V, Grothaus M, et al. Comparison of fracture versus radiolucent table in the treatment of slipped capital femoral epiphysis. *Iowa Orthop J*. 2006;26:33–36.
27. Lee FY, Chapman CB. In situ pinning of hip for stable slipped capital femoral epiphysis on a radiolucent operating table. *J Pediatr Orthop*. 2003;23:27–29.
28. Ward WT, Stefko J, Wood KB, et al. Fixation with a single screw for slipped capital femoral epiphysis. *J Bone Joint Surg Am*. 1992;74:799–809.
29. Karol LA, Doane RM, Cornicelli SF, et al. Single versus double screw fixation for treatment of slipped capital femoral epiphysis: a biomechanical analysis. *J Pediatr Orthop*. 1992;12:741–745.
30. Castro FP Jr, Bennett JT, Doulens K. Epidemiological perspective on prophylactic pinning in patients with unilateral slipped capital femoral epiphysis. *J Pediatr Orthop*. 2000;20:745–748.
31. Schultz WR, Weinstein JN, Weinstein SL, et al. Prophylactic pinning of the contralateral hip in slipped capital femoral epiphysis: evaluation of long-term outcome for the contralateral hip with use of decision analysis. *J Bone Joint Surg Am*. 2002;84-A:1305–1314.
32. Riad J, Bajelidze G, Gabos PG. Bilateral slipped capital femoral epiphysis: predictive factors for contralateral slip. *J Pediatr Orthop*. 2007;27:411–414.
33. Zide JR, Popejoy D, Birch JG. Revised modified Oxford bone score: a simpler system for prediction of contralateral involvement in slipped capital femoral epiphysis. *J Pediatr Orthop*. 2011;31:159–164.