Medial transphyseal screw placement for spastic hip treatment in children with cerebral palsy. Effectiveness and safety

Francisco Praglia,*# Florencia Lucioni,* Juan Pablo Cucchiara*

Pediatric Orthopedic Surgery Department, Maternal and Child Section, Hospital Militar Central "Cir. Mayor Dr. Cosme Argerich" (Buenos Aires, Argentina)

#*Pediatric Trauma Unit, Hospital Nacional "Prof. Alejandro Posadas" (Buenos Aires, Argentina)*

ABSTRACT

Introduction: Animal and clinical studies have shown promising results for the varus-producing placement of a medial eccentric transphyseal screw. The purpose of this study was to establish if the placement of a screw in the proximal femur is an effective and safe approach for spastic hips in children with cerebral palsy (CP). **Materials and Methods:** We compared two groups of pediatric CP patients (Gross Motor Function Classification System [GMFCS] III, IV and V) with "hips at risk." Group A patients were treated with soft-tissue release plus a medial eccentric transphyseal screw in the proximal femur. Group B patients were only treated with soft-tissue release. Patients were evaluated pre- and postoperatively to determine their Rang test score, Reimer's migration percentage (MP), neck-shaft angle (NSA), and complications. **Results:** From a total of 18 patients operated, 36 hips 55% (10) belonged to Group A and 45% (8) to the Group B. The median age was 51 months (IQR, 41-108). The median follow-up was 3 years (IQR, 2.4-5.8). The comparative analysis of all preoperative and postoperative variables yield only one statistically significant difference: the median left hip NSA (-5 vs. 0, P 0.02). **Conclusions:** The release of soft tissues was effective to prevent the spastic hip dislocation. The placement of medial eccentric transphyseal screw in spastic hips produced some complications and no beneficial changes. Medial hemiphysiodesis of the hip remains nothing but an attractive theoretical solution for the treatment of problems caused by excessive valgus. However, further studies are warranted.

Key words: Spastic hip; screw; proximal femur; children.

Level of Evidence: III

Colocación de un tornillo transfisario medial en la cadera espástica de niños con parálisis cerebral. Eficacia y seguridad

RESUMEN

Introducción: En estudios experimentales y clínicos, los resultados con el tornillo excéntrico transfisario medial para producir varo fueron alentadores. El propósito de este estudio fue determinar si colocar un tornillo en el fémur proximal es un gesto eficaz y seguro en caderas espásticas de niños con parálisis cerebral. **Materiales y Métodos:** Se incluyó a pacientes con parálisis cerebral infantil y caderas en riesgo. Se compararon la serie A: pacientes con liberación de partes blandas más colocación de un tornillo excéntrico transfisario medial en el fémur proximal y la serie B: pacientes solo con liberación de partes blandas. Se determinaron el test de Rang, el índice de migración de Reimer, el ángulo cervicodiafisario y las complicaciones, antes de la cirugía y después. **Resultados:** Se operó a 18 pacientes (36 caderas): 10 de la serie A y 8 de la serie B, con una mediana de edad de 51 meses y una mediana de seguimiento, de 3 años. Al comparar por delta de medianas todas las variables preoperatorias y posoperatorias, hubo una diferencia estadísticamente significativa solo en el delta de mediana del ángulo cervicodiafisario de las caderas izquierdas (-5 vs. 0, p 0,02). **Conclusiones:** La liberación de partes blandas es eficaz para prevenir la luxación de la cadera espástica. La colocación de un tornillo transfisario excéntrico en la cadera espástica no produjo cambios y no fue inocua. La hemifisiodesis medial de la cadera es una atractiva solución teórica para tratar los problemas ocasionados por el valgo excesivo, pero se requieren más estudios.

Palabras clave: Cadera espástica; tornillo; fémur proximal; niños.

Nivel de Evidencia: III

Received on August 30th, 2019. Accepted after evaluation on March 8th, 2020 • FRANCISCO PRAGLIA, MD • franciscopraglia@gmail.com ID https://orcid.org/0000-0002-4576-8350

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INTRODUCTION

CP in children is a neurological disorder developing brain secondary to a lesion in the developing brain of children under 5 years of age.[1] These patients' primary symptoms are not limited to hypertonia as they may include others, such as poor balance, weakness, and loss of selective motor control. The most common type of CP in children is spasticity. The GMFCS is currently the most widely used method to classify children with CP based on the child's functional abilities and limitations.[2] It is the best method to interpret the disorder severity and the prognosis for walking.

The pathophysiology of spastic hip dysplasia differs from that of developmental dysplasia of the hip. Spastic hips result from muscle imbalance and secondary bony deformities which are worsened by the lack of weight-bearing. Spastic adductor and flexor muscles, associated with weakened abductor and flexor muscles, cause increased anteversion and coxa valga with a progressive (usually anterolateral) acetabular dysplasia. A primary or secondary pelvic obliquity also contribute to production of hip instability.[3-5] The natural history of spastic hip dysplasia involves a gradual progression over a period of several years. The more severe the CP, the faster progression toward dislocation.[5] Early surveillance and preventive treatment of dislocation in spastic hip patients aim to avoid or delay bone surgery.

A dislocated hip in CP patients worsens their quality of life as it triggers a vicious circle of pain, irritability, and increasing spasticity. Hip dislocation and spine deformities cause considerable difficulties to caregivers in terms of sitting the child, maintaining their perineal hygiene, and changing their clothes. In addition, moving a child with joint contractures from the wheelchair to the bed is an activity that may impose heavy physical demands on the caregiver.

Bedsores condition the patient possibility of being more time in the dorsal position, which would minimize risks of gastro-oesophageal reflux and bronchial aspiration.[3,4] The osseous procedures in both reconstructive and palliative orthopedic surgeries are not without complications and increased morbidity in these patients.[4,5] Early soft-tissue release in patients with "hips at risk" is a very effective method; however, sub-dislocation recurrence is common as children grow.[4]

Guided growth has long been used in skeletally immature patients. Knee, ankle and greater trochanter realignment usually achieve good outcomes.[6-11] The hypothesis to guide the medial growth of the proximal femur is very attractive as it could develop into correcting common children hip problems secondary to excessive valgus with a minimally invasive procedure. Animal studies have shown promising results for the varus-producing placement of a medial eccentric transphyseal screw.[12,13] Recent clinical trials have also reported good results.[14-17]

The purpose of this study was to establish if the placement of a 4.5 mm-diameter, medial eccentric transphyseal screw in the proximal femur is an effective method to produce morphological changes in CP patients' hips.

GENERAL OBJECTIVES

- To establish if the placement of a medial screw in the hip may be considered a helpful procedure auxiliary to soft-tissue release in improving short-term spastic hip dysplasia.
- To establish if the placement of a medial screw in the hip may be considered a safe procedure in children with CP.

MATERIALS AND METHODS

We conducted a retrospective study comparing two groups of cases. The study population was composed of children with CP GMFCS levels III, IV and V, with one or both "hips at risk," treated between 2009 and 2014 at three different centers by the same surgical team. We defined "hip at risk" if the CP patient was under 7 years and had a Rang abduction test of <30° and an antero-posterior (AP) hip X-ray with a Reimer's MP >25%.[4] All patients underwent a preventive surgical procedure for the spastic hip at risk. The surgical protocol consisted of an adductor longus tenotomy and a gracilis tenotomy. If after these procedures the Rang test was <45°, the patient underwent an adductor brevis tenotomy, a neurectomy of the anterior branch of the obturator nerve, and a psoas tenotomy was performed in non-walking children while walking children underwent a myofascial gliding of said tendon.[4] After surgery, both legs were immobilized for 15 days using a bilateral long leg hip type of plaster cast (Figure 1). We named this protocol as soft-tissue release procedure (STRP).

Group A patients underwent STRP and the percutaneous placement of a 4.5 mm-diameter, cannulated, medial eccentric transphyseal screw in the proximal femur under image intensifier guidance, during the same surgical time.

Figure 1. Six-year old patient with cerebral palsy GMFCS level IV. **A.** Preoperative images. **B.** Immediate postoperative with bilateral long leg hip type of plaster cast.

Surgery was performed with the patient in supine position, under general anesthesia, through an approximately 2 cm incision on the thigh lateral aspect, distal to the greater trochanter growth plate. A K-wire was introduced across the femoral neck through the growth plate. The guide K-wire was placed in the inferomedial quadrant (medial half of the femoral head on the AP view) under image intensifier guidance. After drilling the bone, a 4.5 mm, titanium partially threaded, cannulated screw was inserted. The screw was advanced until 3 or 4 threads were inserted in the growth plate. The position was confirmed by fluoroscopy (Figure 2A). A hip arthrography was performed in some cases to rule out the intraarticular migration of the screw (Figure 2B).

Group B patients only underwent STRP.

Clinical and radiological outcome variables

Study variables were: Rang abduction test, pain, perineal hygiene difficulty, and comfort, using the "Caregiver Scale" from the Instituto de Ortopedia Infantil Roosevelt (Bogotá, Colombia),[18] which covers three domains: 1) assistance, 2) positioning and transfers, and 3) comfort. Any simultaneous surgical procedure at a different site was also recorded. We used AP X-rays to measure the NSA and Reimer's MP.

Figure 2. A. The first step of the guided growth surgery is correcting the femur anteversion by internal rotation of the hip until the longest femoral neck is observed on fluoroscopy. A guiding wire is placed. After drilling, a 4.5 mm-diameter, cannulated screw is placed. **B.** A hip arthrography is performed to rule out the intraarticular migration of the screw.

Safety variables

Complications were graded following the Dindo-Clavien classification.[19]

Exclusion criteria

Participant exclusion criteria included: less than a 2-year follow-up, previous hip surgery, history of hip infection or other neuromuscular condition. Outcomes were classified according the dislocation criteria scale for spastic hip proposed by Presedo *et al*.:[20] good if MP is <24%, fair if MP was between 25% and 39%, poor if it was between 40% and 59%, and failure if it was >60%.

Statistical analysis

Continuous variables were described as mean and standard deviation, and categorical variables were described as percentages and absolute values. The preoperative and postoperative median differences of the following variables were compared between Group A results (STRP plus medial screw in the proximal femur) and Group B results (only STRP): right and left hip Rang test, right and left hip MP, and right and left NSA. Continuous variables were compared using Mann Whitney test, and categorical variables were compared using Fisher's test. Values were considered to be statistically significant at $P < 0.05$.

RESULTS

Group A: 10 patients (20 hips); 4 GMFCS IV patients and 6 GMFCS V patients. Group B: 8 patients (16 hips); 2 GMFCS III patients, 3 GMFCS IV patients, and 3 GMFCS V patients. Study population: 13 boys and 5 girls, with a median age of 51 months (IQR, 41-108 months). Of the entire population, 39% (n=7) underwent a single surgical procedure during surgery. The remaining 61% (n=11) underwent a preventive treatment for spastic hip but also other orthopedic procedures at different levels, including selective and reversible chemodenervation with onabotulinumtoxin A in hamstring and gastrocnemius muscles, and hamstring and gastrocnemius tendon repair.

The median follow-up was of 3 years for both groups (Group A IQR, 2.4-4.8 years; Group B IQR, 2.4-5.8 years) (Table 1).

Table 1. Patients' features

	Total n = 18	Group A n = 10	Group B n = 8
Males	13	8	5
Age median (months)	51 (RIC 41-108)	52 (RIC 43-103)	57 (RIC 40-108)
Single surgery	39% (7)	40% (4)	38% (3)
Complications	16,6% (3)	66,6% (2)	33,3% (1)
Follow-up (years)	3 (RIC 2.4-5.8)	3 (RIC 2.4-4.8)	3 (RIC 2.4-5.8)
GMFCS			
III	11% (2)	0	25% (2)
IV	39% (7)	40% (4)	37,5% (3)
V	50% (9)	60% (6)	37,5% (3)

IQR: Interquartile range; GMFCS: Gross Motor Function Classification System

Clinical outcomes

The postoperative Rang test median at last follow-up for the right hip was 50° (IQR, 45°-55°) in Group A and 52° (IQR, 50°-60°) in Group B. The postoperative Rang test median at last follow-up for the right hip was 50° (IQR, 45°-55°) in Group A and 52° (IQR, 50°-60°) in Group B. The median difference for the right hip Rang test was 23° (IQR, 15°-30°) in Group A and 28° (IQR, 18°-35°) in Group B (P=0.3, not statistically significant).

The postoperative Rang test median at last follow-up for the left hip was 23° (IQR, 20°-30°) in Group A and 25° (IQR, 20°-45°) in Group B. The postoperative Rang test median at last follow-up for the left hip was 45° (IQR, 45°-50°) in Group A and 45° (IQR, 43°-55°) in Group B (Table 2).

Table 2. Preoperative and postoperative measurement values

	Total n = 18	Group A n = 10	Group B n = 8
RH preoperative Rang test median	25 (IQR 20-45)	28 (IQR 20-45)	25 (23-25)
LH preoperative Rang test median	20 (IQR 20-45)	23 ((IQR 14-74)	27 (RIC 20-45)
RH preoperative MP median	27 (IQR 15-74)	28 (IQR 14-74)	27 (RIC 23-45)
LH preoperative MP median	30 (IQR 25-83)	31 (IQR 25-83)	33,3% (1)
RH preoperative NSA median	159 (IQR 155-170)	156 (IQR 155-170)	160 (RIC 155-165)
LH preoperative NSA median	160 (IQR 150-170)	162 (IQR 160-170)	160 (RIC 158-168)
RH postoperative Rang test median	50 (IQR 50-60)	50 (IQR 45-55)	52 (RIC 50-60)
LH postoperative Rang test median	45 (IQR 45-55)	45 (IQR 45-50)	45 (RIC 43-55)
RH postoperative MP median	24 (IQR 18-51)	24 (IQR 18-51)	23 (RIC 19-35)
LH postoperative MP median	20 (IQR 18-83)	20 (IQR 17-41)	23 (RIC 19-83)
RH postoperative NSA median	156 (IQR 148-170)	156 (IQR 148-170)	158 (RIC 155-165)
LH postoperative NSA median	159 (IQR 153-170)	153 (IQR 150-170)	160 (RIC 156-170)

RH: right hip; LH: left hip; MP: Reimer's migration percentage; NSA: neck-shaft angle.

The median difference for the left hip Rang test was 25° (IQR, 25°-25°) in Group A and 20° (IQR, 15°-30°) in Group B (P=0.3, not statistically significant). The "Caregiver Scale"[18] scores dropped (improved) in the three domains: A patient from Group A complained of persistent pain in the left hip after surgery, and consequently screws were removed 8 months after surgery. Nevertheless, there were no statistically significant differences between the groups (P=0.2).

Radiographic results

Right hip

MP. Group A: preoperative median, 28% (IQR, 14%-74%); postoperative median, 24% (IQR, 18%-51%). Group B: preoperative median, 27% (IQR, 23%-45%); postoperative median, 23% (IQR, 19%-35%). MP median difference was 3% (IQR, –12%-21%) in Group A and –2% (IQR, –9%-8%) in Group B (P=0.56, not statistically significant).

NSA. Group A: preoperative median, 156° (IQR, 155°-170°); postoperative median, 156° (IQR, 148°-170°). Group B: preoperative median, 160° (IQR, 155°-165°); postoperative median, 158° (IQR, 155°-165°). NSA median difference was –1° (IQR, –7°-5°) in Group A and 0° (IQR, 0°-0°) in Group B (P=0.2, not statistically significant) (Table 2).

Left hip

MP. Group A: preoperative median, 31% (IQR, 25%-83%); postoperative median, 20% (IQR, 17%-41%). Group B: preoperative median, 28% (IQR, 23%-46%); postoperative median, 23% (IQR, 19%-83%). MP median difference was –9% (IQR, –23°-5°) in the A Group A and –5° (IQR, –6°-38°) in the B Group A (P=0.3, not statistically significant).

NSA. A Group A: preoperative median, 162° (IQR, 160°-170°); postoperative median, 153° (IQR, 150°-170°). B Group A: preoperative median, 160° (IQR, 158°-168°); postoperative median, 160° (IQR, 156°-170°). NSA median difference was –5° (IQR, –10°-0°) in Group A and 0° (IQR, –2°-3°) in Group B (P=0.2, statistically significant difference).

All Group A patients evidenced distal screw migration associated with growth (Figures 3 and 4).

Figure 3. Anteroposterior hip radiographs. Four-year old patient with cerebral palsy GMFCS level IV. **A.** Eight months after surgery. There is an emerging distal screw migration in both hips. **B and C.** Screw migration increased over time (years).

Figure 4. Anteroposterior hip radiographs. Pediatric patient with cerebral palsy GMFCS level IV. **A.** Four years before surgery. **B.** Immediate postoperative period. **C.** Distal screw migration in both hips over time.

Based on the MPs and their effect on avoiding bone surgery, Group A results were: good, 55%; fair, 25%; poor, 15%; failure, 5%. Accordingly, Group B outcomes were: good, 50%; fair, 31%; poor, 13%; failure, 6% (P=0.1, not statistically significant) (Figures 5 and 6).

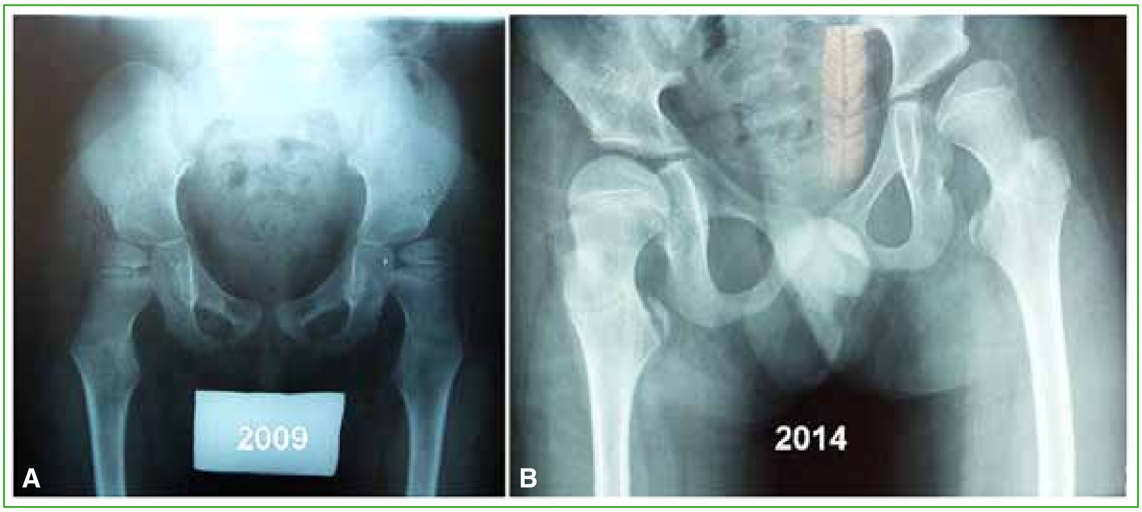

Figure 5. Anteroposterior hip radiographs. Five-year old patient with cerebral palsy GMFCS level III. **A.** Both hips at risk. **B.** Five years after bilateral soft-tissue release, the patient had had no hip dislocations and presented stable values for Reimer's migration percentage and the neck-shaft angle.

Figure 6. Anteroposterior hip radiographs. Six-year old patient with cerebral palsy GMFCS level V. **A.** Both hips with a Reimer's migration percentage >60%. **B.** At 12 years of age, 5 years after bilateral soft-tissue release, the patient not only had had no hip dislocations but patient's radiographic values also improved.

Safety variables

Complications were graded following the Dindo-Clavien classification.[19]Group A, 2 complications: a grade III b complication, pain in the left hip that required transphyseal screw removal 8 months after surgery (Figure 7); and a grade I complication, the head of the screw broke during placement and another one had to be placed in a parallel position. Group B, 1 complication: a grade II complication, superficial infection of the surgical wound. The analysis showed there was no statistically significant difference between groups (P=1).

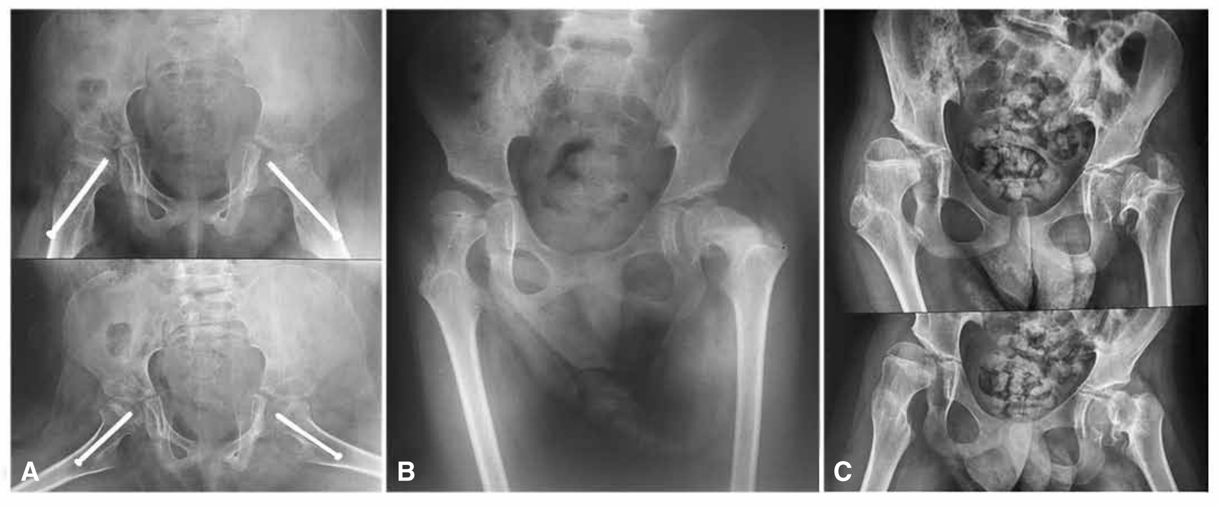

Figure 7. Patient with cerebral palsy (spastic tetraparesis) GMFCS level IV. **A.** Anteroposterior and lateral hip radiographs from the immediate postoperative period. **B.** Anteroposterior hip radiograph taken 20 months after the removal of both hip screws. Image evidences a growth plate medial closure in the left hip with varus deformity. **C.** Anteroposterior and lateral hip radiographs taken 4.5 years after surgery. *Left hip*: coxa brevis and coxa vara with an overriding greater trochanter. *Right hip*: anteversed coxa valga with spastic dysplasia progression. Reimer's migration percentage >50%.

DISCUSSION

Current animal and clinical studies on the guided growth of the medial proximal femur are reporting good results.[12-17] We failed to find Argentinian literature on the matter.

Experimental studies

McCarthy *et al.*[12] published the first pilot study in an animal model. They allocated 10 lambs into two groups of five lambs each: five had the screw placed across the inferior growth plate in one of their hips, and the other 5 had the screw was placed in the femur neck but not across the growth plate as a sham procedure. The transphyseal screw group showed an NSA reduction averaging 11°. This difference was considered as statistically significant, representing close to an 8% reduction of the normal NSA value, d'Heurle *et al.*[13] published an animal study which objective was to produce a varus deformity of the proximal femur. They performed proximal femoral hemiepiphysiodeses using a screw, an 8-plate or a drilling procedure in groups of 4 lambs each. The screw technique was the only method that resulted in a statically significant decreased NSA compared with the contralateral side (a 7° average reduction). This difference represents close to a 6% reduction of the normal NSA value.

These two studies[12,13] raised issues that needed further research: if these changes are temporary and if they may be reversed with removal of the implant. And they shared the same limitations: a small sample size, and the use of a quadruped model.

Clinical studies

Portinaro *et al.*[16] published a protocol for the management of CP children, which included hip medial hemiepiphysiodesis. The publication is of an informative nature and reports no specific results.

Wei-Chun Lee *et al.*[14] reported a case series that included nine children (averaging 6 years of age) with CP GMFCS levels IV and V. Five children underwent unilateral hip surgery and 4 children underwent bilateral hip surgery. All surgeries included soft-tissue release and guided growth with a 7 mm-diameter, cannulated, medial screw in the affected hips. The average follow-up was 3.8 years. The authors measured the NSA before surgery and three times during the follow-up period (at 3-month, 1-year and 2-year control follow-up). The study reports a significant 12°-average NSA reduction, representing a 7% reduction. This result is equivalent to those of the aforementioned experimental studies.[12,13]

In addition, Wei-Chun Lee *et al.*[14] reported an average NSA of 173.3° at 3-month follow-up, 166.4° at 1-year follow-up, and 162.7° at 2-year follow-up. The NSA difference between month 3 and year 1 was significant (P<0.001, power=0.86), but not that was not the case between years 1 and 2 (P=0.15, power=0.81). After the first postoperative year, NSA change progression did not parallel the patients' growth. This fact correlates with the outcome scale classification based on the follow-up MPs reported in the study tables: good, 7.7% (MP<24%); fair, 61.5% (MP between 25% and 39%); poor, 23% (MP between 40% and 59%); failure, 7.7% (MP>60%) . These results may be more associated with soft-tissue release than with hemiepiphysiodesis.

Unlike our study, Wei-Chun Lee *et al.*[14] reported no complications in their study; however, they reported a progressive distal screw migration in all cases, as in our study.

Portinaro *et al.*[17] published the largest case series on medial hemiepiphysiodesis in spastic hip, which included 28 patients (7 GMFCS III, 9 GMFCS IV, 12 GMFCS V) who underwent bilateral hip surgery, using soft-tissue release plus a 4.5 mm-screw medial placement in the proximal femur, with a minimum follow-up period of 5 years. Patients were clinically and radiographically evaluated before surgery, at 6 months, 1 year and 5 years. Six patients (9 hips) had distal screw migration at 24 months after surgery. In one of them, with both screw migration, one of the screws broke (screw head breakage) during replacement. The NSA reduction averaged 14° at a five-year follow-up. They reported an "important MP decrease" at a 5-year follow-up, but the absolute average is 9%. The authors suggest that medial screw hemiepiphysiodesis may be useful to prevent progressive hip dislocation even in high-risk patients. However, in their series, spastic dysplasia progressed to dislocation in 4 out of the 12 GMFCS V patients, who required reconstructive surgery.

Torode and Young[15] evaluated the use of guided growth in the proximal femur with a medial transphyseal screw for treating caput valgum associated with developmental dysplasia of the hip. Patients with hip dysplasia secondary to neuromuscular conditions or other teratologic conditions were excluded. The study population consisted of 11 patients (13 hips), averaging 9.25 years at surgery. The average follow-up period was of 5 years. Radiographic evaluations included femoral and acetabular measurements. They reported a significant average NSA reduction, from a preoperative 173° to 158° at the latest follow-up. The NSA decreased 8.6% in average. The authors concluded that caput valgum early identification may be treated using a 7 mm-diameter, medial transphyseal screw in the proximal femur. The improvement in the physeal orientation and NSA reflects the effectiveness of guided growth principles in the proximal femur.

In a study on reducing the need for bone surgery in children with CP and spastic hip dysplasia, Presedo *et al.*[20] reported substantial scientific evidence. They operated on 65 patients (129 hips), averaging 4 years at surgery, with a 10-year mean follow-up. Forty-seven (72%) children were unable to walk. Patients' outcomes were: good, 55%; fair, 14%; poor, 3%; failure, 27%. A new soft-tissue release was not considered a failure.

In our study, we report the outcomes of two groups of similar pediatric patients with spastic hips at risk. We compared the outcomes of using an STRP plus a medial eccentric transphyseal screw in the proximal femur (intended to produce a hemiepiphysiodesis resulting in a varus deformity) serving as an adjunct, and those of using only STRP. We found no significant differences between the groups, at a mean follow-up of a little more than 4 years, in terms of clinical parameters (such as Rang test for both hips) and most radiographic parameters (such as both hip MP and the right hip NSA).

The left hip NSA had a statistically significant difference (P=0.02). This difference can be ascribed to a complication: a Group A patient developed a final growth plate medial closure in the left hip. In our case series, there were 2 non-minor complications, on a total of 20 hips (10%). A screw breakage during placement, and a patient with persistent pain that required a new surgery to remove the implant with the subsequent final growth plate medial closure in the left hip.

Regarding the purpose of this study, the placement of a 4.5 mm-diameter, medial eccentric transphyseal screw in the proximal femur was not an effective method to produce morphological changes in the hips. The method failed to produce changes in the comparative analysis of the preoperative and postoperative median MP and NSA values between groups (Table 3, Figure 8). The only statistically significant difference found pertained to the left hip median NSA (–5 vs. 0; P=0.02). No morphological changes were found in the patients' proximal femurs, other than the left hip growth plate closure developed by one patient following the screw removal.

With respect to the general objectives, we failed to validate the placement of a medial screw in the hip as a helpful procedure auxiliary to soft-tissue release in improving short-term spastic hip dysplasia (average follow-up, 51 months). We were able to establish that the placement of a medial screw in the hip of children with CP cannot be considered a safe procedure, i. e., it is not without complications. All screws showed distal migration during

Table 3. Median differences comparison

	Total n = 18	Group A n = 10	Group B n = 8	p
RH Rang test median difference	25 (RIC 15-35)	23 (RIC 15-30)	28 (RIC 18-35)	0.3
LH Rang test median difference	25 (RIC 20-30)	25 ((RIC 25-25)	20 (RIC 15-30)	0.3
RH MP median difference	-1 (RIC -10 a -1)	3 (RIC -12 a 21)	-2 (RIC -9 a 8)	0.56
LH MP median difference	-5 (RIC -13 a 38)	-9 (RIC -23 a 5)	-5 (RIC -6 a 38)	0.3
RH NSA median difference	0 (RIC -5 a 5)	-1 (RIC -7 a 5)	0 (RIC 0-0)	0.2
LH NSA median difference	-2 (RIC -5 a 3)	-5 (RIC -10 a 0)	0 (RIC -2 a 3)	0.02

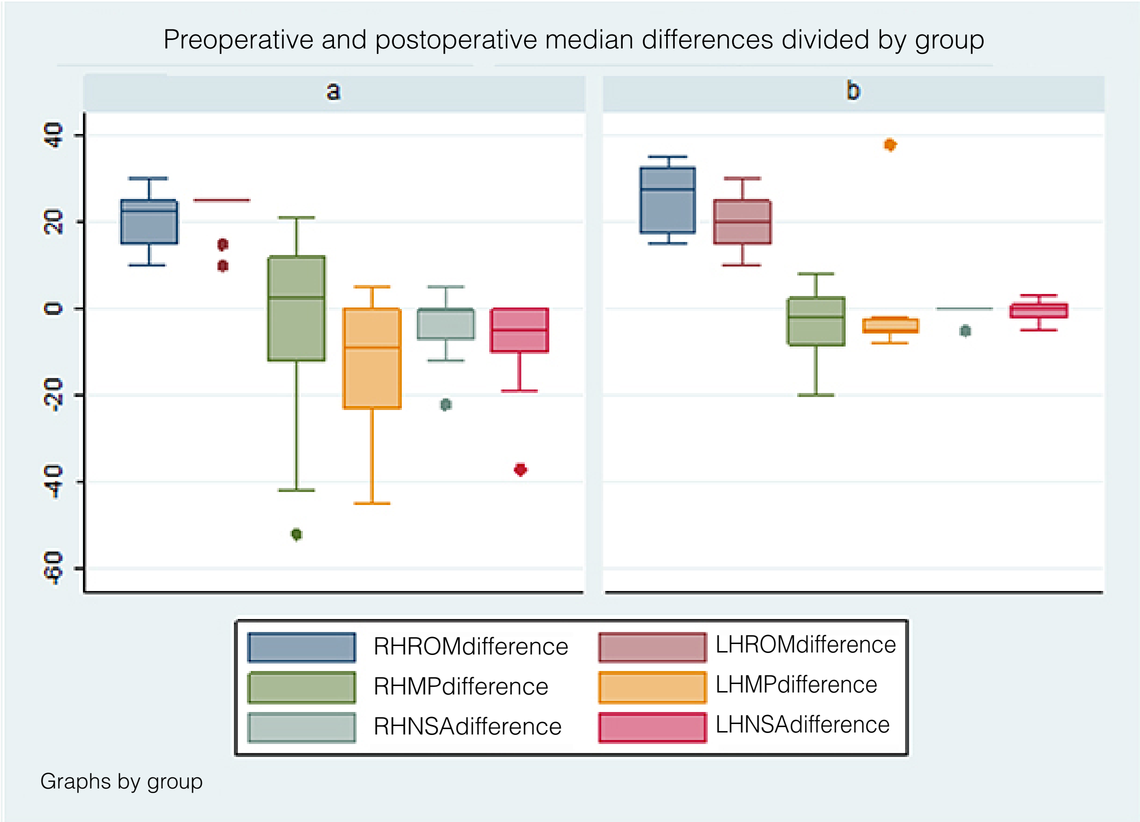

Figure 8. Preoperative and postoperative median differences of both groups. RH: right hip; LH: left hip; MP: Reimer's migration percentage; NSA: neck-shaft angle.

follow-up. Considering the high preoperative morbidity of this population and the additional cost of another procedure, the decision was made not to change screws, nor to add another one, during follow-up in cases of backed out screws. Such events would suggest epiphysiodesis failure, and so no radiographic measurement changes are expected to be found. Some authors considered that screws backing out a year or two after surgery do not affect the final outcome.[14]

The limitations of the study include a limited number of patients and a limited follow-up period, because no patient follow-up covered the patient prepubertal growth spurt, period when the levels of deterioration, recurrence and sub-dislocation progression are expected to be the highest. However, at a 4-year mean follow-up, there were no significant differences between the rates of patients with different MP; patients outcomes: good, 55% vs. 50% (Group A vs. Group B); fair, 25% vs. 31%; poor, 15% vs. 13%; failure, 5% vs. 6% (P=0.1, not statistically significant).[20]

The concept of guided growth of the proximal femur as described in this study reviewed literature[12-17] is very attractive as it promises a potential solution of a biological and less invasive nature to the problems posed by spastic hip dysplasia in children with CP. However, after a thorough analysis of the pertaining studies and of the comparison of their results to ours, we have some concerns. All these studies[12-17] are consistent in showing a NSA reduction of 6-8% relative to baseline values. Hips that are not subject to the deforming forces of spastic muscles may obtain enough benefit from an approximate 8% NSA change to alter the natural evolution of caput valgum following the developmental dysplasia of the hip, but this is not likely to be the case for spastic hips. Spastic hip are the result of muscle imbalance. Increased anteversion and coxa valga cause progressive acetabular dysplasia. This whole scenario is only worsened by the lack of weight-bearing.[21] If the pathophysiology of the spastic hip is *extraphyseal*, why would its solution by at the growth plate? With respect to the interpretations provided by other authors,[14,17] how can they guarantee that the 6-8% NSA improvement (especially during the first postoperative year) stems from the proximal femur medial hemiepiphysiodesis and not from the effect of the soft-tissue release? In addition, accuracy and reproducibility is challenging in pediatric radiographic measurement as placing children in an optimal radiographic position may prove difficult.

CONCLUSIONS

The placement of a 4.5 mm-diameter, medial eccentric transphyseal screw in the proximal femur was not an effective method to produce morphological. We do not recommend preventive treatment for spastic hip to be supplemented with a medial eccentric transphyseal screw in the proximal femur as it is not a safe procedure, it increases complication risks, and its supporting scientific evidence is not conclusive.

Given the potential benefit and relative low morbidity of the guided growth of the proximal femur, further and larger studies are warranted, involving more case series, case-control trials and larger follow-up periods.

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F. Lucioni ORCID: https://orcid.org/0000-0002-9097-5113
J. P. Cucchiara ORCID: https://orcid.org/0000-0002-3105-7478

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