Infantile Hip Arthroscopy: The Relationship between Neurovascular Anatomy and the Portal Pathway

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Objective: *In the past, studies of hip arthroscopy portal path relate with extra-articular structures were done in adults. This study was investigated in the infantile group.*
Material and Method: *10 hips of fresh infantile cadavers. K-wire diameter 2.4 mm. are representing scope pathway. Three portals (anterior, anterolateral and posterolateral) in supine position without traction were chose to used in this study.*
Results: *One cadaver was female and four were male. The mean age and weight when death occurred was 74 days and the mean weight was 3,584.4 gm. At the anterior portal, the most lateral branch of LFCN was frequently injured. The average distant of femoral nerve to the K-wire was 11.2(7-14) mm. Transverse branch of lateral femoral circumflex artery had an average distant 8.5(6-14) mm and the terminal branch could be identified in four hip and average distance was 1mm. At the anterolateral portal two, greater trochanter were injuried by K-wire. In the posterolateral portal the average distant from K-wire to sciatic nerve was 13.2 mm.*
Conclusion: *From this pilot study, the distance of major neurovascular structure as related to hip scope path is nearly a centimeter on average.*

Keywords: *Hip arthroscopy, Hip anatomy, Neurovascular anatomy, Infant hip arthroscopy*

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Hip arthroscopy has become a less invasive surgery that is now widely accepted in diagnosis and treatment of hip disease in adults and children[1,2]. Septic arthritis of the hip in adults and adolescents treated with arthroscopy have shown positive results with outstanding benefits compared to open arthrotomy including less morbidity, visualized magnification, and direct suction with large-bore and large-volume lavage in the joint[3-5]. However, the benefit from this technique remains a question in infants. Serious complication in developmental dysplastic hip (DDH) that relates with inappropriate reduction was osteonecrosis or recurrent subluxation[6,7]. Successful hip arthroscopy without complication in treatment of DDH condition has been reported, but the numbers of patients were small and the age of patients were late infants or small children[6]. The smallest infants previously reported to have received hip arthroscopic examination were more than 1,700 g in body weight. This previous study tested the possibility of hip arthroscopy in newborn, followed described arthroscopic examination techniques and picked the tissue to demonstrate intra-articular hip structure[8].

Even though previous reports have shown the benefits and possibility of hip arthroscopy in infants, this procedure is still a challenge because there are many aspects of infant anatomy that differ from the one of adults such as more femoral anteversion at birth that decreases until skeletal maturation[9] and unossified femoral head, which cannot be seen under fluoroscope. Previous studies on basic anatomic safety that relate to hip arthroscopy were all conducted in adults[10,11].

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The purpose of this paper is to study the neurovascular anatomic related with portal pathway in infant hip arthroscopy and also to describe the technique that may be used for infant hip arthroscopy.

Material and Method

Between March 2006-Febuary 2008 six fresh infantile cadavers (age of death is 0-365 days) donated to the hospital by their parents were included in the study. The causes of death or treatments before death in every cadaver did not involve the lower extremity. One of the cadavers was excluded because he had femoral vein cut down for blood exchange in the groin area. Therefore, a total of ten hips from five fresh cadavers were included in the study.

Surgical technique

The cadavers were set in supine positions without traction. A small volume of contrast media was injected from the lateral side of the hip to outline the hip cavity (Fig. 1).

Leakage of contrast media were avoided because leaks can obscure hip visualized under fluoroscope. After no leakage of contrast media from the joint was confirmed, more volume of contrast media was used to further distend the hip joint. Three portals were chosen in the study (anterior, anterolateral, posterolateral portals). Portal placement was simulated in cadaveric hip specimens. This was achieved by passing three Smooth Kirschner wire (K-wire) diameter 2.4 mm into the hip joint under fluoroscopic control. Briefly, the technique for portal placement was to follow the skin landmark of the anterior portal that coincides with the intersection of a vertical line drawn distally from the anterior superior iliac spine and a transverse line across the superior margin of the greater trochanter or the pubic symphysis. The direction of the portal is approximately 45 degree cephalad and 30 degree towards the midline. The anterolateral and posterolateral portals were positioned directly over the margin of the greater trochanter at its anterosuperior and posterosuperior edge of the trochanter respectively[10]. The sequence in portal placement started from the anterolateral portal to the anterior portal and then with posterolateral portal (Fig. 2).

After finishing the placement of portal track, anatomic dissections were conducted layer by layer. Measurements of the shortest distant from the K-wire to the organ structure were recorded. After the study, all cadavers were sutured and the defects repaired.

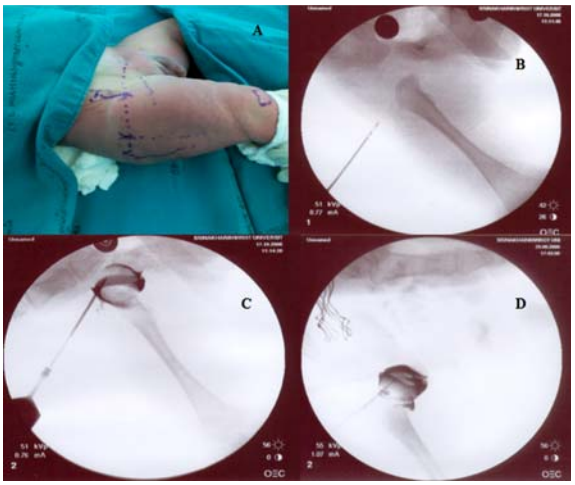

Fig. 1 (A) drawing skin landmark, (B) femoral head is cannot be seen and contrast media was injected from the lateral, (C) small volume of contrast media to outline hip cavity, (D) further distend joint cavity

Fig. 2 (A) picture after finish pin placement, (B) under fluoroscope view, (C) K-wire penetrating the hip capsule

This study has been approved by the ethic committee of the Faculty of Medicine at Srinakharinwirot University.

Results

Four cadavers were boys and one was a girl. The mean age of deaths was 74 days. The average weight of the cadavers was 3,584 grams. The demographic data of all cadavers were presented in the Table 1.

Table 1. General cadaver demographic data

No.	Death age (day)	Gender	Cause of death	Weight (gm)	Visualized ossification center at femoral head underfluoroscope
1	138	Female	Sepsis, pneumonia	5,730	-ve
2	27	Male	Sepsis, bowl perforate	3,200	-ve
3	44	Male	Trisomy 13, airway obstruction, congenital heart failure	2,960	-ve
4	160	Male	Pre term, sepsis, NEC	2,580	-ve
5	1	Male	Death at birth	3,462	-ve
Mean death age 74 days				Mean weight at death 3584.4 grams	

Anterior portal

Lateral femoral cutaneous nerves (LFCN) were mostly divided in three to five terminal branches (Fig. 3). The most lateral branch was frequently injured by the K-wire with the mean distance of just 0.5 mm. The average distance of femoral nerve from the K-wire was 11.2 (7-14) millimeters.

Transverse branch of lateral circumflex femoral of artery had the average distance of 8.5(6-14) millimeters from the K-wire (Fig. 4) and the terminal branch that divided from this artery can be identified in four hips and two of them were injured so the mean distant is only 1 (0-3) (millimeter).

Anterolateral portal

After the K-wire passed the skin and soft tissue, it passed through gluteus medius muscle and penetrated the hip capsule. There were two hips where the tips of the greater trochanters were injured by the K-wire.

Posterolateral portal

The K-wire passed gluteus medius and minimus then entered the hip capsule. The mean distant from K-wire to sciatic nerve was 13.2 mm (8-20).

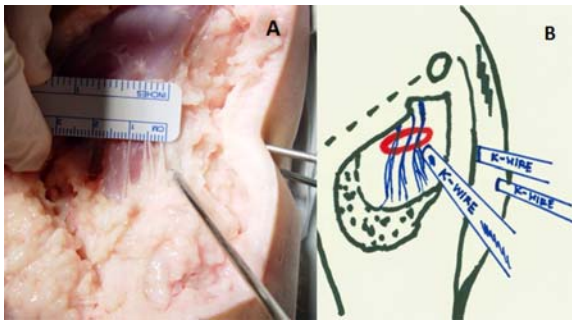

Fig. 3 (A) multiple terminal braches of LFCN, (B) diagram, within red circle are the terminal braches of LFCN, the path of portal (represented by K-wire) is quite near the most lateral branch

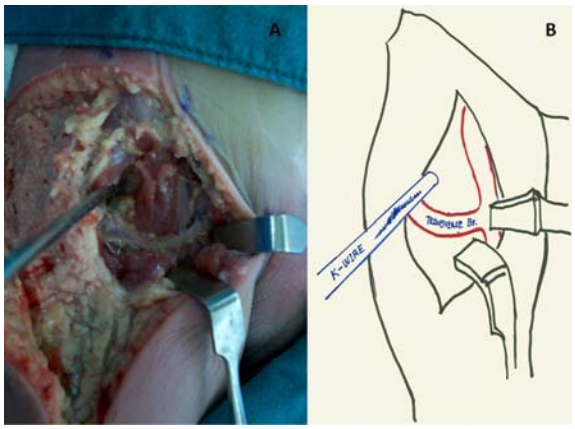

Fig. 4 (A) transverse branch of lateral femoral circumflex artery, (B) diagram show this artery pathway beneath the K-wire

Discussion

The average distance from the major neuro-vascular to the arthroscopic pathway (represented by K-wire) in this study (femoral nerve = 11.2 mm, Sciatic nerve = 13.2 mm) was relatively wide when compared to the size of infant limb. Caution in skin landmark of the starting portal is important because piercing the K-wire more distally just a half centimeter represent a high risk of injury to the transverse branch of lateral femoral circumflex artery. From this study, the terminal branch of this artery has a high risk of injury because, on average, the distance is only just 1mm. These terminal branch injuries mentioned have no clinical significance[10].

Table 2. Detail of the distant from structure to the portal path

Portal	Anatomic structure	Average distant (mm)	Range (mm)
Anterior	Lateral femoral cutaneus nerve	0.5	0-1.5
	Femoral nerve	11.2	7-14
	Transverse branch of lateral circumflex femoral artery*	8.5	6-14
	Terminal branch of lateral circumflex femoral artery**	1	0-3
Posterolateral	Sciatic nerve	13.2	8-20
Anterolateral	Two hips were injured at the tip of greater trochanter by K-wire piercing , all K-wire passed the gluteus medius muscle before entering capsule		

* as show in Fig. 4, ** can identify in 4 hips

Injection of contrast media in this technique is a necessary step to identify hip cavity but eventually can become troublesome. The leakage of contrast media from the joint cavity should be avoided. Early in the study, there was contrast media leakage, so the authors had to wait until the contrast media did not obscure the hip and then repeat the procedure. In the later cases, just an initial small volume of contrast media was injected. After making sure that the tip of the needle is in the hip cavity, more contrast media was injected.

Sekiya et al used arthroscopic hip combined with the limited open approach for reduce risk of extra-articular injury in adult[12]. Kaminski et al successfully used this combination technique in septic hip without complications[13]. The combined technique may be the answer to avoid the use of contrast media and may be able to reduce extra-articular complications. Bulut et al has shown the benefit of arthroscopic assisted reduction when combined with the limited open approach for the DDH condition[5]. In DDH condition, arthroscopy may be another technical detail but a recent report shows a new animal model for hip arthroscopy already[14].

Until present, this is the first research with an aim to determine the relationship of the anatomy and hip arthroscopy pathway in whole fresh body infant cadavers whom the average size by weight was equal to a full term baby. The defect in this study were the lag of the incident of labrum and cartilage injury, small numbers of cadavers and not using the real scope set up, so this study can be a pilot study in infantile group. Furthermore, numbers of cadavers and use of the real instrument should be arranged for future study.

Conclusion

From this pilot study, the distance of major neurovascular structure as related to hip scope pathway, are nearly centimeters in average.

Acknowledgement

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การส่องกล้องข้อสะโพกในเด็กวัยแรกเกิด: ความสัมพันธ์ของแนวระบบประสาท และหลอดเลือดกับแนวทางของการสอดกล้อง

ชลวิช จันทร์ลลิต, ธัญญวัฒน์ สายสงเคราะห์, รัฐวุฒิ รักษากุลเกียรติ, ยิ่งยง ต่ออุดม

วัตถุประสงค์: *เด็กทารกมีภาวะแตกต่างจากผู้ใหญ่ในแง่ขนาดและสัดส่วนของข้อสะโพก ในอดีตความรู้เรื่องกายวิภาคที่อาจเกิดอันตราย จากการทำการส่องกล้องข้อสะโพกเป็นงานวิจัยที่ศึกษาในศพผู้ใหญ่ การศึกษานี้จึงเป็นการศึกษาในข้อสะโพกเด็กวัยแรกเกิด*

วัสดุและวิธีการ: *ข้อสะโพกวัยแรกเกิดจำนวน10 ข้อสะโพก โดยใช้ K-wire 2.4 มิลลิเมตรแทนแนวทางของการสอดกล้องโดยจัดในท่านอนหงายและใช้ 3 แนวทางของการสอดกล้อง (anterior, anterolateral and posterolateral portal) ในการศึกษานี้*

ผลการศึกษา: *เป็นหญิง 1และชาย4 ราย อายุเฉลี่ยที่เสียชีวิต 74 วัน และน้ำหนักตัวเฉลี่ย 3,584.4 กรัม ที่ anterior portal พบว่าระยะเฉลี่ยห่างจากแขนงริมนอกสุดของ lateral femoral cutaneus nerve มีค่าเฉลี่ย 0.5 มิลลิเมตร ในส่วนของ femoral nerve มีระยะห่างเฉลี่ยที่ 11.2 มิลลิเมตร transverse branch ของ lateral femoralcircumflex artery วางตัวลงไปใต้ต่อ portal โดยเฉลี่ย 8.5 มิลลิเมตร ส่วน terminal branch นั้นสามารถแสดงได้เพียง 4 สะโพก และมีค่าเฉลี่ย 1 มิลลิเมตร ที่ anterolateral portal มีการแทงผ่านปลาย greater trochanter ถึง 2 สะโพก ที่ posterolateral portal มีระยะห่างเฉลี่ย 13.2 มิลลิเมตร กับ sciatic nerve*

สรุป: *จากการศึกษานำนี้ระยะห่างของเส้นประสาทและเส้นเลือดที่สำคัญกับการส่องกล้องข้อสะโพกในเด็กวัยแรกเกิดมีระยะค่าเฉลี่ยประมาณเกือบเซนติเมตร*