รายงานโครงการวิจัย

เรื่อง

ความแม่นยำในการประมาณความยาวของสายสวนเส้นเลือดแดงสายสะดือของทารกแรกเกิดด้วยระยะระหว่าง suprasternal notch และ superior iliac spine

Accuracy of the distance between suprasternal notch and superior iliac spine to determine umbilical arterial catheter length

โดย

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สารบัญ

สารบัญตารางและแผนภูมิ

หน้า

บทคัดย่อ

วัตถุประสงค์: เพื่อศึกษาความแม่นยำของระยะระหว่าง suprasternal notch และ superior iliac spine ในการประมาณความยาวสายสวนเส้นเลือดแดงสายสะดือของทารกให้ปลายสายสวนอยู่ในตำแหน่งระดับกระดูกสันหลังระดับอกที่ 6 และ 10

วัสดุและวิธีการ: เป็นการศึกษาไปข้างหน้าในทารกแรกเกิดในหออภิบาลผู้ป่วยทารกแรกเกิดวิกฤติ โรงพยาบาลธรรมศาสตร์เฉลิมพระเกียรติ ที่ต้องใส่สายสวนเส้นเลือดแดงสายสะดือจำนวน 52 ราย โดยใส่สายสวนเส้นเลือดแดงสายสะดือด้วยความยาวเท่ากับระยะระหว่าง suprasternal notch และ superior iliac spine ประเมินปลายสายสวนเลือดแดงสายสะดือเทียบกับตำแหน่งระดับกระดูกสันหลังระดับของทารกแต่ละคนโดยอ้างอิงกับภาพรังสีบริเวณช่องท้องและช่องอก และประเมินความน่าเชื่อถือของการวัดโดยวัดซ้ำและเปรียบเทียบระยะระหว่าง suprasternal notch และ superior iliac spine 2 ครั้ง

ผลการศึกษา: การประมาณความยาวสายสวนเส้นเลือดแดงสายสะดือด้วยระยะระหว่าง suprasternal notch และ superior iliac spine มีความแม่นยำมาก พบว่าปลายสายสวนอยู่ในตำแหน่งระหว่างระดับกระดูกสันหลังระดับอกที่ 6 และ 10 อย่างถูกต้องทุกรายในการใส่สานสวนครั้งแรก (ร้อยละ 100) ค่า repeatability coefficient ซึ่งแสดงความแตกต่างในการวัดซ้ำของระยะระหว่าง suprasternal notch และ superior iliac spine เป็น 0.7 เซนติเมตร

สรุป: การประมาณความยาวสายสวนเส้นเลือดแดงสายสะดือให้ปลายสายสวนอยู่ในตำแหน่งระหว่างระดับกระดูกสันหลังระดับอกที่ 6 และ10 ด้วยค่าความยาวระหว่าง suprasternal notch ถึง superior iliac spine นั้นมีความแม่นยำ น่าเชื่อถือและง่ายต่อการวัด

Abstract

Objectives: This study aimed to validate the SSSL in pre-exterminating the insertional length at between the sixth and tenth thoracic vertebrae (T6-T10) and examine repeatability property.

Material and Method: A prospective recruitment of 52 babies who were placed the umbilical arterial catheter in the NICU, Thammasat University Hospital was performed. Insertional length of the distance between suprasternal notch and superior iliac spine (SSSL) were performed. The catheter tips were verified against anatomical points on chest and abdominal radiograph. The SSSL was measured twice on each patient to indicate repeatability property.

Results: All babies (100 percent accuracy) were correctly placed the catheter tips at high placement (T6 to T10) at the first attempt. Repeatability coefficient for repeating measure of the SSSL was 0.7 centimeters.

Conclusion: The SSSL is repeatable, simple, and perfectly accurate for pre-determination of the umbilical arterial catheter length to position the catheter tip at T6 - T10.

Keywords: Umbilical arterial catheter, simple, accurate, estimation, length, high placement, SSSL, suprasternal notch, superior iliac spine

Introduction

The insertion of a catheter into the umbilical artery of a newborn is an important procedure for drawing blood samples, measuring blood pressure, and administering fluid and medications[1,2]. Appropriate placement of the catheter tip is important to minimize vascular complications including hemorrhage and ischemic damage to organs[1-3]. The catheter is considered high placement if the tip is between the sixth and tenth thoracic vertebrae (T6-T10) on the radiograph[4]. A Cochrane meta-analysis recommended use of initial high placement of umbilical arterial insertion to minimize occurrence of vascular complications, removal, and other adverse sequele[5]. A variety of methods to pre-determine umbilical arterial insertion was used differently from centers to centers[6-11]. Recently, the distance between suprasternal notch to superior iliac spine length (SSSL) was proposed by the author for rapid calculation of insertion by a single neonatal morphometric measure[12]. This study, therefore, aimed to validate the SSSL in pre-exterminating the insertional length at high placement and examine repeatability property.

Material and method

This study was approved by the Thammasat University Human Ethics Committee. Entry criteria were babies, without gross anomaly, who had clinical need to umbilical arterial access in the neonatal intensive care unit (NICU), Thammasat University Hospital. Umbilical arterial radio-opaque catheter was used with aseptic technique for catheter insertion. Suprasternal notch to superior iliac spine length (SSSL) was measured and was added up with the umbilical stump length to obtain the insertional length. Location of the catheter tip was determined by a radiograph of the chest and abdomen. Catheter position was adjusted by withdrawal or by re-insertion if the first insertional catheter tip was placed out of T6-T10 levels. The SSSL distance was repeatedly measured in all babies within 48 hours after the first measurement.

Proportion of catheters correctly positioned with the catheter tip at between T6-T10 on initial radiography was calculated for accuracy percent. Repeatability coefficient, defined as half the 95% reference range for differences between repeat measurements on the same subject, equaled $2\sqrt{2}$ of standard deviation (SD) of the difference[13].

Results

There were 52 babies, 29 boys and 23 girls, with the mean birth weight of 2,090 grams $\pm$ 936 grams (range of 740 grams and 4,215 grams). The mean gestational age was 34.1 $\pm$ 4.2 weeks (range of 26 and 42 weeks). Birth weights and gestational ages were detailed in table 1. All babies (100 percent accuracy) were correctly placed the catheter tips at high placement (T6 to T10) at the first attempt.

The mean SSSL distance of the first and second measures on the same patient were 14.78 centimeters (SD = 2.02 centimeters) and 14.67 centimeters (SD = 1.99 centimeters) respectively. The standard deviation (SD) of the difference (measurement error between observations on the same patient) was 0.24 centimeters. The 95% reference range for the measurement error was between -0.35 and 0.35 centimeters. Therefore, repeatability coefficient for repeating measure of the SSSL ($2\sqrt{2}$ of SD of the difference) was 0.7 centimeters.

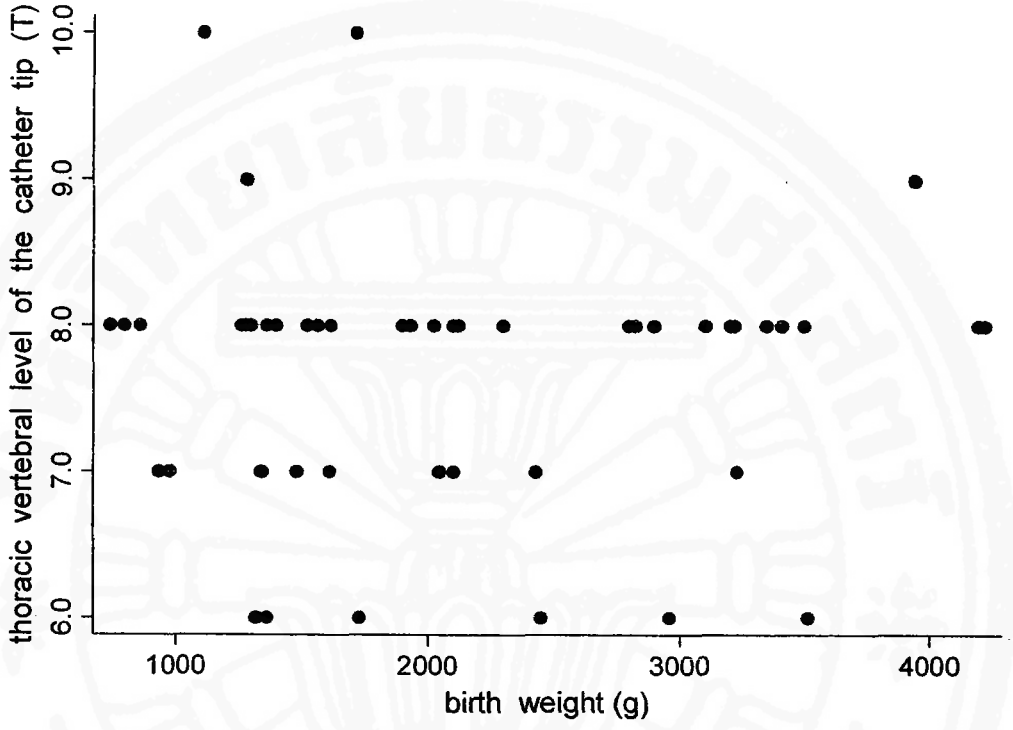
The plot between birth weight against the level of vertebrae of the catheter on radiograph was showed in Figure 1. Concerning catheter tips at the more precise placement as between T7 and T9 on the radiograph, there were 43 cases (83 %), 7 cases (13%), and 2 cases (4%) correctly inserted, overinserted, and underinserted respectively. There were 3 cases (10%) and 4 cases (17%) overinserted in neonates with birthweight under and over 2000 grams respectively. There were 2 cases (7%) and 0 cases (0%)

underinserted in neonates with birthweight under and over 2000 grams respectively. Incorrect insertion of the catheter tips (beyond T7 and T9) was not significant associated with birtheweight under or over 2000 grams (p-value= 0.521 by Fisher exact test).

Table 1. Birth weights and gestational ages of the babies studied

	N=52	Percent
Birth weight (g)		
740-999	5	9
1000-1499	14	27
1500-2500	18	35
2500- 3999	13	25
4000-4215	2	4
Gestational age (weeks)		
26-27	3	6
28-36	32	61
37-39	16	31
42	1	2

Figure 1. Relationship between birth weight and vertebral level of the catheter tip on radiograph



Discussion

A variety formula has been used to pre-determine the insertional length for high placement[6-11]. Nomograms from Dunn's post-mortem study that was used to calculate the insertional length was published in 1966[6]. Deriving several formulas using morphometric measures to calculate the insertional length have been reported. Weaver and Algren developed a formula as heel to crown length X 0.33 while Rubin' et al proposed the distance of baby's xyphoid process to his pubis adding up with the distance from the pubis to mid-umbilicus[7,8]. Birth weight was also used to derive formula to calculate the insertional length. Shukla and Ferrara reported a formula of [3 X BW(kg)] + 9 , which has been used widely[9]. However, using the formula of Shukla and Ferrara has been claimed a consistent overestimation of catheter insertional length in smallest infants[14]. The formula, [4 X BW(kg)] +7, proposed by Wright IM, et al has been recently reported to have good result but for only special group of very low birth weight infants[11].

Recently, the author has selected the SSSL among several morphometric measures as a new formula after comparing the accuracy and reliability in pre-determine the insertional length with those of previous used formulas[12]. Perfect accuracy result in this study confirms using this SSSL in pre-determination of the insertional length at high placement, between T6-T10 levels. However, the catheter tips tend to place higher thoracic vertebral level than T8 (or T6-T7 levels) regardless of birth weight as seen in figure 1. This SSSL

was well repeatable with low repeatability coefficient of only 0.7 centermeters. In practice, the SSSL distance has to add up with the umbilical cord stump length to obtain the final insertion length.

In conclusion, the SSSL is perfectly accurate for pre-determination of the umbilical arterial catheter length to position the catheter tip at T6 and T10 regardless birth weight.

Acknowledgements

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ภาคผนวก

Data collecting form

โครงการวิจัย UAC

Exclude if having gross anomaly

Estimated Cath length=supraternal notch to left superior iliac spine + umb stump length

HN (neonate) _____ AN (neonate) _____

Mother name _____

Sex (0=male, 1=female) [ ]

ga (gestational age, เศษตั้งแต่ +4 วัน คิดเป็น 1 สัปดาห์) _____ weeks

HC .....cm (1 decimal)

age (post natal age at catheterization) .....days

birthw (birth weight, g) ..... g

body (total body length, 1 decimal) ..... cm

supiliac1 (supraternal notch to Left superior iliac spine, 1 decimal) ..... cm

Catheterization

stump (estimated umbilical stump length, 1 decimal) ..... cm

cathl (Cath length ดูที่ scale ของ cath เมื่อใส่เสร็จแล้ว) ..... cm

revise (จำนวนครั้งที่ต้องเลื่อนสายสวน)..... .. times

recath (จำนวนครั้งที่ต้องใส่สายสวนใหม่)..... .. times

X-ray

tipcath1 (By x-ray, tip of cath at T?, eg t 8 or t 9.5, 1 decimal) level T.....

rexray (จำนวนครั้งที่ x-ray จนปลายสายสวนอยู่ในตำแหน่งที่ต้องการ (T 6-10))..... .. times

Measurement2

Supiliac2 (second time: supraternal notch to Left superior iliac spine, 1 decimal)

..... cm