RESEARCH PAPER

Comparison of JSS Formula with Modified Shukla's Formula for Insertion of Umbilical Venous Catheter: *A Randomized Controlled Study*

Sushma Krishnegowda, Deepti Thandaveshwar, Meghana Mahadevaswamy and Srinivasa Murthy Doreswamy

From Department of Pediatrics, JSS Medical college Hospital, JSS University, MG Road, Mysuru. Karnataka, India.

Correspondence to: Dr Sushma Krishnegowda, Department of Pediatrics, JSS Hospital, Agrahara, Mysuru 570 004, Karnataka, India. drsushmasri@gmail.com
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Objective: To compare the rate of optimal position of UVC between modified Shukla's formula and JSS formula. **Methods**: Babies requiring umbilical vein catheterization were randomized to either Shukla or JSS formula group. Post-procedure *X*-ray was taken to check the tip position. Tip of the UVC just above the diaphragm (T9 - T10) was considered optimal. Success rate in achieving optimal position between the two groups were compared. **Results**: Out of 104 babies recruited, 50 were randomized for Shukla's formula and 54 for JSS formula. Catheter tips were in acceptable positions in 39.6% of Shukla group as compared to 56% in JSS group (*P*=0.02). **Conclusion**: The JSS Formula resulted in more optimal placement of UVC than the modified Shukla formula.

Keywords: *Accuracy, Complication, Exchange transfusion, Neonate.*

Umbilical vein catheterization (UVC) is widely practiced in neonatal units for various indications. UVC tip lying at the junction of inferior vena cava and right atrium is considered most optimal position. Placement of UVC tip at the optimal position mitigates many serious complications associated with UVCs [1-4]. To achieve the optimal placement, formulae used presently involve multiple steps in calculation [5-8] and are associated with a significant failure rate [6-8]. The most common method used for confirmation of tip position is antero-posterior abdomen-chest radiography [9]. Based on birth weight and length needed to insert UVC to optimal position, we derived a simple formula (JSS formula) which is 6.5 + weight in kg. We hypothesized that, this simple formula was not inferior to modified Shukla's formula in the rate of achieving optimal position at first attempt of UVC insertion.

Methods

This was a randomized controlled trial conducted in a tertiary NICU. All neonates needing insertion of UVC were eligible. Babies who had UVC inserted earlier and undergoing repeat procedure and babies more than 7 days of age were excluded from the study. Institutional ethical committee approved this study. Informed consent was taken from the parents prior to insertion of UVC.

To achieve an 80% optimal position in the JSS group compared to 50% in the Shukla formula group with a power of 90% and alpha error of 5%, we needed to study 51 Subjects in both groups. The analysis was on an intention-to-treat basis.

UVCs in the Shukla group were sited using modified Shukla's formula [10]. Babies in the JSS group had UVC length calculated using JSS formula which is 6.5 cm + weight in kg for babies ≥1.0 kg , 6.5 cm for babies weighing 0.75-0.99 kg, and 6 cm for babies between 0.5-0.749 kg. The JSS formula was derived by reviewing 100 check skiagrams after UVC insertion.

Computer generated randomization was done. One of the authors calculated the desired length of insertion as per the randomization order and informed the doctor inserting the UVC. Under standard aseptic precautions, umbilical vein catheter was inserted to the desired length. A free back flow of blood into the syringe was considered as successful insertion. After the procedure, a check supine abdomen-chest *X*-ray was obtained and interpreted by another author.

Tip of the UVC lying just above the diaphragm (T9 – T10), between upper border of T8 and T9 (lower one third of the cardiac shadow, just above the diaphragm) or at the liver edge was considered acceptable. Catheter tip in any of the other positions was considered unacceptable to use and hence had to be removed immediately. Cather tip seen in portal or hepatic veins was also considered unacceptable.

RESULTS

We randomized 104 neonates – 50 to Shukla's formula and 54 to JSS formula group. Baseline characteristics of the study groups are depicted in ***Table* I**.

The success of placement of UVC to the desired length in the first attempt was similar in both groups. Table II depicts the rates of acceptability and non-acceptability of UVC placement using the two formulae.

DISCUSSION

The present study showed higher success rate in achieving the optimal position of UVC with JSS formula compared to using the Shukla formula.

On many occasions, the catheter remains in the normal course but either falls short or overshoots the optimal location rendering it unusable. Such issues can be addressed by a good formula or surface landmark which helps in calculating the appropriate length of the catheter to be inserted. Earlier studies have shown around 24% and 41% of the UVCs to be in optimal position when either Dunn or Shukla's formula, respectively were used [10,11].

Our study has demonstrated that the proportion of catheters falling short of length to reach optimal position to be significantly lower in JSS formula group compared to Shukla's formula group. This may also explain the lower proportion of the catheter in deviant course when Shukla's formula was used. Had these catheters been advanced; some of them were likely to deviate and match the proportion in JSS formula group.

The strength of the study was that both the person inserting and the person reading *X*-rays were blinded to the formula used to estimate the depth of insertion. All the *X*-rays were read by a same investigator.

Limitation of the study was that the umbilical vein catheter was inserted by different physicians and the technique of insertion was bound to vary.

We conclude that the new JSS Formula achieves an optimal placement of UVC in a higher proportions than the modified Shukla formula.

Contributors: SK: study design, analyzing the data and preparing the manuscript; MM: collected the data, literature search and helped in manuscript preparation; DT: collected the data, did the literature search and contributed for analysis of data and preparation of the manuscript; SD: literature search, analysis of data and contributed to the study concept and design. He also provided critical inputs to manuscript preparation. All the authors approved the final version of manuscript for submission. *Funding*: None; *Competing Interest*: None stated.

TABLE I BASELINE CHARACTERISTICS OF NEONATES

Variables	*Shukla formula (n = 50)*	*JSS formula (n = 54)*
*Age at insertion (hr)	10 (4-45)	14 (6-26)
*Gestation (wk)	37 (30-38)	37 (32-38)
*Birthweight (g)	2320 (1300-2790)	2350 (1540-2800)
Male gender	30 (60%)	34 (63%)
Indications for UVC placement		
Multiple	31 (62%)	34 (63%)
Total parenteral nutrition	1 (2%)	2 (4%)
Inotropes	7 (14%)	7 (13%)
Exchange transfusion	8 (16%)	10 (19%)
Hypoglycemia	3 (6%)	1 (2%)
Complication: False passage	1 (2%)	1 (2%)

*All values no (%) except *Median (IQR)*

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TABLE II COMPARISON OF ACCEPTABLE CATHETER PLACEMENTS IN THE TWO GROUPS

	Shukla (n = 50)	*JSS (n = 54)*	*P value*
Successful insertion in first attempt	48 (96%)	52 (96.3%)	0.563
Acceptable position	19/48 (39.5%)	28/52 (53.8%)	0.023
Tip at T9-T10 (optimal)	15/19 (79%)	25/28 (89.2%)	
Tip at t8-T9 or at Liver edge (suboptimal)	4/19 (21%)	3/28 (10.8%)	
Unacceptable position	29/48 (60.5%)	24/52 (46.2%)	
Tip in portal hepatic vein	10/29 (34.5%)	17/24 (70.8%)	
Short of length to acceptable position	19/29 (65.5%)	7/24 (29.2%)	

WHAT THIS STUDY ADDS?

- JSS formula achieves a higher rate of placing the tip in the optimal position compared to commonly used Modified Shukla's formula.

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