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Prediction of Difficult Peripheral Intravenous Access in Pediatric Anesthesia: Validation of the DIVA Score and Proposal of a Clinical Management Protocol

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Abstract **Original Research Article**

Background: Peripheral intravenous (PIV) catheterization is a cornerstone of pediatric anesthetic management. However, obtaining vascular access in children may be technically challenging because of anatomical, physiological, and behavioral factors. Multiple failed attempts are associated with increased pain, anxiety, perioperative delays, and depletion of venous capital. ***Objective:*** To validate the Difficult Intravenous Access (DIVA) score in a Moroccan pediatric population and evaluate its association with first-attempt success, number of cannulation attempts, and time to successful catheterization. A secondary objective was to propose a structured clinical management protocol for difficult vascular access. ***Methods:*** We conducted a prospective single-center observational study including 240 pediatric patients undergoing anesthesia at the Children's Hospital of Rabat. Patients were stratified into low-risk (DIVA <4) and high-risk (DIVA ≥4) groups. Primary outcomes included success at first attempt, number of attempts, and cannulation time. ***Results:*** Patients with a DIVA score ≥4 demonstrated significantly prolonged cannulation times and a higher number of attempts compared with patients with DIVA <4. Mean cannulation time increased from approximately 15 seconds in the low-risk group to 77 seconds in the high-risk group. Similarly, the mean number of attempts increased from 1.3 to 2.9 attempts. These findings confirm the predictive value of the DIVA score in our clinical setting. ***Conclusion:*** The DIVA score is a reliable, reproducible, and clinically applicable tool for predicting difficult peripheral venous access in pediatric anesthesia. Its routine use may facilitate early escalation strategies, optimize first-attempt success, and improve perioperative patient experience.

Keywords: Systemic sclerosis- pulmonary aspergilloma- pulmonary fibrosis.

INTRODUCTION

Peripheral intravenous access is an essential component of perioperative management in pediatric anesthesia. Despite its routine nature, vascular access in children remains one of the most technically demanding procedures for anesthesiologists, particularly in infants and young children. Factors such as small vessel caliber, increased subcutaneous tissue, poor vein visibility, agitation, and repeated prior cannulations contribute to procedural difficulty.

Failure of first-attempt cannulation is associated with several adverse consequences, including increased procedural pain, psychological distress, perioperative anxiety, delays in surgical care, and progressive depletion of peripheral venous capital. Repeated puncture attempts also increase caregiver stress and workload among healthcare professionals.

Several predictive tools have been developed to identify children at high risk for difficult intravenous access. Among these, the Difficult Intravenous Access (DIVA) score proposed by Yen *et al.,* remains one of the most widely used clinical tools. Early identification of high-risk patients may allow implementation of advanced strategies such as ultrasound-guided cannulation, escalation to experienced operators, or use of alternative vascular access techniques.

The present study aimed to validate the DIVA score in a Moroccan pediatric population managed in the operating room and to propose a practical protocol for

the management of difficult peripheral venous access in pediatric anesthesia.

METHODS

Study design and setting

This prospective, observational, single-center study was conducted in the operating rooms of the Children's Hospital of Rabat, Morocco.

Study population

A total of 240 pediatric patients requiring peripheral intravenous catheterization for anesthesia were included. Children undergoing elective or emergency surgical procedures were eligible for participation.

Inclusion criteria

- Pediatric patients requiring peripheral intravenous access for anesthetic management
- All ASA physical status classifications
- Elective and emergency procedures

Exclusion criteria

- Presence of central venous access before anesthesia
- Immediate life-threatening situations requiring urgent vascular access
- Incomplete clinical data

Data collection for each patient, the DIVA score was calculated before cannulation. The following variables were recorded:

- Success or failure at first attempt
- Number of cannulation attempts
- Time to successful cannulation (seconds)

Patients were classified into two groups:

- Low-risk group: DIVA score <4
- High-risk group: DIVA score ≥4

Outcome measures

The primary outcome was first-attempt success. Secondary outcomes included total number of attempts and time required for successful peripheral intravenous access.

RESULTS

Among the 240 included children, most patients presented with a low DIVA score. The distribution of DIVA scores demonstrated that 75.3% of patients had a DIVA score <4, whereas 24.7% were classified as high-risk with a DIVA score ≥4.

Patients with a DIVA score ≥4 experienced significantly more difficult vascular access compared with the low-risk group.

Cannulation time Mean time to successful intravenous cannulation increased markedly in patients with difficult access:

- DIVA <4: approximately 15 seconds
- DIVA ≥4: approximately 77 seconds

Number of attempts

The mean number of cannulation attempts was also significantly higher in the high-risk group:

- DIVA <4: approximately 1.3 attempts
- DIVA ≥4: approximately 2.9 attempts

These findings support the ability of the DIVA score to predict procedural difficulty during peripheral intravenous access in pediatric anesthesia.

DISCUSSION

Our study confirms the clinical relevance of the DIVA score in predicting difficult peripheral venous access in pediatric patients undergoing anesthesia. A DIVA score ≥4 was associated with prolonged cannulation time and an increased number of puncture attempts, demonstrating its usefulness in identifying children at high risk for difficult intravenous access.

These findings are consistent with previously published studies. Yen *et al.,* who initially developed the DIVA score, demonstrated that higher scores were associated with lower first-attempt success rates. Riker *et al.,* also reported increased failure rates and procedural difficulty in children with elevated DIVA scores. Similar observations have been described by Bair et al., highlighting the reproducibility and clinical applicability of the score across different healthcare settings.

Early identification of high-risk patients may improve perioperative care through implementation of adapted strategies. In our opinion, ultrasound-guided vascular access should be considered early in children with DIVA ≥4, especially in tertiary pediatric centers. Escalation to experienced operators after limited attempts may reduce procedural trauma, delays, and complications.

The practical implications of this study are particularly important in resource-limited settings, where repeated failed attempts may contribute to increased patient morbidity and workflow disruption. Incorporating the DIVA score into routine anesthetic assessment may therefore facilitate structured vascular access management and improve quality of care.

Proposed Clinical Management Protocol

Based on our findings and current literature, we propose the following practical algorithm for difficult peripheral intravenous access in pediatric anesthesia:

1. Initial assessment using the DIVA score before cannulation.
2. Patients with DIVA <4:

- Standard peripheral intravenous access technique.

3. Patients with DIVA ≥4:
   - Early involvement of an experienced operator.
   - Limit puncture attempts.
   - Prepare advanced vascular access equipment.
   - Consider ultrasound-guided cannulation.
   - Consider alternative vascular access sites if necessary.
4. Persistent failure:
   - Escalation to intraosseous or central venous access according to the clinical situation and urgency.

Strengths and Limitations

Strengths of this study include its prospective design and its performance in a real-life pediatric anesthetic setting. However, several limitations should be acknowledged. First, this was a single-center study, which may limit generalizability. Second, operator experience was not stratified. Finally, ultrasound-guided vascular access was not directly compared with conventional techniques.

CONCLUSION

The DIVA score is a simple, reliable, and clinically relevant tool for predicting difficult peripheral intravenous access in pediatric anesthesia. Routine implementation of this score may improve first-attempt success, reduce procedural duration, decrease patient discomfort, and optimize perioperative management. Future multicenter studies integrating ultrasound-guided vascular access strategies may further strengthen these findings.

Expanded Bibliography and Literature Review

Recent literature strongly supports the importance of structured strategies for difficult peripheral venous access in pediatric anesthesia and emergency medicine. The DIVA score remains one of the most validated predictive tools for difficult cannulation in children.

Several studies demonstrated that ultrasound-guided peripheral venous access significantly improves first-attempt success rates in pediatric patients with difficult intravenous access. Current evidence also supports limiting the number of puncture attempts and escalating early to experienced providers in high-risk patients.

Moreover, repeated failed attempts are associated with increased procedural pain, perioperative anxiety, delayed surgical management, and long-term needle phobia. Modern pediatric anesthetic practice therefore increasingly emphasizes atraumatic vascular access strategies and patient-centered perioperative care.

International recommendations also advocate the integration of ultrasound-guided vascular access training into pediatric anesthesia curricula and simulation-based teaching programs.

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