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Risk factors for Hickman-Broviac catheter complications: An experience from a Tunisian hospital

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ABSTRACT

Background: Hickman-Broviac catheters have improved the care of young children needing frequent and prolonged venous access, but at the same times it has substantial morbidity, particularly in a resource-constrained setup. Our study aims to describe the experience of a Tunisian hospital and investigate the main risk factors for complications.

Methods: In this study, we included all the neonates and infants who underwent Broviac catheter insertion in the pediatric surgery department. The patients were divided into 2 groups according to the presence of complications. We compared these two groups and univariate logistic regression analyses were used to determine the risk factors for complications.

Results: Forty-three children were included in the study. The incidence of complicated catheters was 60.4%. The following factors were significantly associated with an increased risk of complications: age 6 months [OR 3.5, 95% CI: 0.6-19.3], weight 6 kg [OR 1.54, 95% CI: 0.46-5.2], emergency circumstances [OR 1.62, 95% CI: 0.8-5.4], and antibiotic-therapy as an indication for Broviac catheter insertion [OR 1.8, 95% CI: 0.5-6.2].

Conclusion: Complications seem to be more frequent in patients younger than 6 months and those with a weight of less than 6Kg. To reduce the morbidity related to the catheters, the indications should be carefully chosen.

INTRODUCTION

Hickman-Broviac catheters are tunneled central venous catheters used for managing children needing frequent and prolonged venous access for several reasons, like chemotherapy, parenteral nutrition, and blood sampling. [1] It can also be useful in children with difficult venous access. It needs a surgical insertion under general anesthesia and special nursing later. [2] Although Hickman-Broviac catheters have improved the care of these children, they are associated with substantial morbidity. [3] Therefore, the indications and patients should be selected carefully to reduce this morbidity. [1] However, in developing countries suffering from the lack of experience in the management of central catheters, the absence of written protocols, inadequate nursing care, and the absence of other alternatives to manage difficult venous access, particularly in children, indications and patient selection can be neglected. [4]

The aim of this study is to describe the experience of a Tunisian university hospital in the management of Hickman-Broviac catheters and to investigate risk factors for complications.

METHODS

Study design and settings: A prospective observational study was conducted after obtaining local ethics committee approval and informed oral consent of the parents. We collected data from neonates and infants who were hospitalized or referred to the pediatric surgery department in the Hedi Chaker University Hospital in Sfax (Tunisia), for surgical catheter Broviac insertion from January 2020 to June 2021, with 3 months of follow-up after catheter insertion.

Participants: In this study, we included all neonates and infants who were proposed for catheter Broviac surgical insertion. We did not include patients over the age of 12 months or those with contraindications

(hemostasis troubles, severe infection, cutaneous infections or burns, or risk of superior cava vein syndrome). We did not include patients who had had a Broviac catheter insertion outside the operating room of the pediatric surgery department (ex: in the pediatric intensive care unit or in the neonatology department). We excluded patients who had an immediate anesthetic or surgical complication or failure of Broviac insertion. We also excluded patients who died before the removal of the catheter. We included 50 patients in the study. Seven of them were excluded because they died before the catheter was removed. All deaths were not related to catheter insertion or complications (4 patients from pediatric intensive care and 3 from neonatal intensive care). All patients excluded, died within 10 days of Broviac catheter insertion. We analyzed the data of the remaining 43 patients.

Variables and Data measurement: The variables included age, weight, sex, previous comorbidities, the department in which the patient was admitted, the circumstances of insertion, and particularly the duration of insertion. The indications for the Broviac catheter insertion were noted (antibiotic administration, perioperative context, parenteral nutrition, and chemotherapy).

The main outcomes were the incidence of complications (infection, bleeding, mechanical complications like fracture, occlusion, accidental removal, or thrombosis), and the lifetime of the catheter, defined by the duration between insertions and removal. Early removal of the catheter was defined as catheter ablation within 10 days of insertion.

Bias: In this study, all patients received the same anesthesia protocol. All patients had general anesthesia with Sevoflurane induction and maintenance with oral intubation. All Broviac catheters were inserted under the same conditions (in the operation room with respect to aseptic conditions) by the same team in the internal jugular vein.

Patients included were divided into 2 groups according to the incidence of complications.

Group C: included 26 patients who presented with any complication related to the Broviac catheter (infection, bleeding, thrombosis, or any other mechanical complication).

Group NC: included 17 patients whose catheters were not complicated.

Statistical analyses: All statistical analyses were achieved using the SPSS 23.0 (SPSS, Chicago, IL, USA) statistical package. Continuous variables were presented as means value ±standard deviation in the case of a Gaussian distribution and as medians in the case of a non-Gaussian distribution. Two groups were identified based on the incidence of complications. The comparison between groups was achieved by Student's t-test and Chi-square test for continuous variables and categorical variables, respectively. The Fisher exact test was used when the Chi-square test was not applicable. The Mann-Whitney U test was used for non-parametric continuous variables. To assess the predictors of Broviac catheter complications, univariate logistic regression analyses were used to determine the crude odds ratio with the 95% approximate confidence intervals. The significance level was set at $p<0.05$.

RESULTS

Descriptive data

The average age of patients included was 3.16 ±2.8 months. The sex ratio (M/F) was 3.3. The average weight was 4.155 ±3.2 Kg. The main comorbidities were: prematurity (65.1%), respiratory disease (25.6%), neurological disease (14%), cardiac disease (7%), and cancer (7%). The past history of contralateral Broviac catheter insertion was seen in 6 patients. Departments requesting Broviac catheters were neonatology (37.2%), pediatric intensive care (32.6%), pediatrics (16.3%), pediatric surgery (11.6%), and oncology (2.3%).

The main indications were: antibiotic administration for a long period (51.2%), perioperative context (23.3%), parenteral nutrition (18.6%) and chemotherapy (7%). Twenty Broviac catheters (46.5%) were inserted in emergent circumstances.

A Broviac catheter was inserted in the right internal jugular vein in 37 patients (86%), and in the left one in 6 patients (14%) with a past history of contralateral Broviac.

Early removal of the catheter was seen in 18 patients (41.8%), fourteen of them because of the incidence of a complication. In the 4 remaining cases, the Broviac catheter was inserted preoperatively and was removed within a few days just before the patients' exit. The average lifetime of a Broviac catheter was 11.3±4.3 days. It was less than 10 days in 18 patients (41.8%).

Outcome data

The comparison of the two groups is summarized in table 1.

The following factors were significantly associated with an increased risk of complications: age 6 months [OR 3.5, 95% CI: 0.6-19.3], weight 6 kg [OR 1.54, 95% CI: 0.46-5.2], emergency circumstances [OR 1.62, 95% CI: 0.8-5.4], and antibiotic-therapy as an indication for Broviac catheter insertion [OR 1.8, 95% CI: 0.5-6.2]. The department in which the patients were admitted was not a risk factor for complications. The early removal of the catheter (<10 days) was seen in 23.5% in the non-complicated group versus 53.8%

in the complicated group with p=0.04 and it was correlated to complications [OR= 3.75; 95% CI: 0.53 – 26.1].

DISCUSSION

In this study, younger age (<6 months) and lower weight (<6 kg) were factors predisposing to complications. Insertion circumstances (emergency context) and indications can be also risk factors for complications.

The incidence of complications related to Broviac catheters in our population was higher than in the literature. [5] Previous studies showed that the complication rate was less than 20%. [5, 6] This may be due to our population, which includes critically ill neonates and young infants with severe prematurity and comorbidities, but also to the quality of healthcare. [7, 8] The management of these tunneled catheters needs special nursing skills. [9] Safe and successful use of the Broviac and Hickman catheters depends upon the skillful management of a multidisciplinary team [10] that avoids the risks of nosocomial infection, occlusion caused by the precipitation of drugs or parenteral nutrition, and venous thrombosis and stenosis. [11]

Table 1: Risk factors for Broviac catheter complications.

	Group C N=26	Group NC N=17	OR [95% CI]	P value
Age <6months	17 (65.4%)	16 (94.1%)	**3.5 [0.6-19.3]**	**0.031**
Weight < 6kg	18 (69.2%)	16 (94.1%)	**1.54[0.46-5.2]**	**0.029**
Sex (Male/Female)	15/11	11/6	0.54 [0.15-1.9]	0.441
Comorbidities	23	10	0.48 [0.2-1.1]	**0.001**
Prematurity	18 (69.2%)	10 (58.8%)	1.30 [0.3-4.6]	0.469
Emergency	14(53.8%)	6 (35.2%)	**1.62 [0.8-5.4]**	**0.015**
Duration of insertion procedure (min)	31.2 ± 8.5	29.5± 8.1	1.01 [0.68-3.2]	0.092
Premature catheter removal	14 (53.8%)	4 (23.5%)	**3.75 [0.53-26.1]**	**0.040**
Patient admitted in :				
Neonatology	7 (26.9%)	9 (52.9%)	2.18 [0.62-7.7]	0.182
Pediatric intensive care	10 (38.4%)	4 (23.5%)	0.92 [0.25-3.3]	0.583
Pediatrics	5 (19.2%)	2 (11.7%)	0.74 [0.17-2.61]	0.316
Pediatric surgery	4 (15.3%)	2 (11.7%)	0.82 [0.12-5.5]	0.613
Indications:				
Oncology	1 (3.8%)	2 (11.7%)	1.29 [0.16-10.1]	0.133
Parenteral nutrition	3 (11.5%)	5 (29.4%)	0.68 [0.2-2.38]	0.125
Antibiotic-therapy	16 (61.5%)	6 (35.2%)	**1.80 [0.5-6.2]**	**0.050**
Peri-operatively	6 (23.0%)	4 (23.5%)	0.91 [0.54-1.73]	0.889

Several studies showed that younger age and lower weight are risk factors for complications, but they did not determine the threshold of age and weight at risk of complications after Broviac catheter insertion since this study found it. [12] We used this threshold of six months and 6kg of weight by analogy with previous studies showing that age under 6 months was correlated with difficult venous access [13] and central catheter-related complications. [14] We should mention that following the true indications for Broviac

catheter insertion is mandatory for safety. It was indicated initially for parenteral nutrition [1], but now it is used to provide venous access for patients requiring other types of long-term intravenous therapy [15], like patients in pediatric hematology and oncology. [3] In developing countries, the indications can be neglected because of the absence of other alternatives in difficult venous access management like midline, PICC (peripherally inserted central catheter), and intraosseous access. [16] It was reported that Broviac catheters had a significantly higher infection rate than PICCs, but PICCs were more likely to break. Although Broviacs® and PICCs had similar complication rates (infection, breakage, or occlusion), when comparing the same-size catheters (3F), there was less central venous thrombosis associated with PICCs. [17] Ultrasound-guided percutaneous central catheters can be a safe alternative in children but need skilled and experienced pediatric intensivists. [18] This may explain why the Broviac catheter was requested in an emergency in our study and why it was inserted in perioperative patients that would need venous access for a short period. In our study, the main indication was antibiotic-therapy for a long period. This particular indication was related to a higher risk of complications, particularly nosocomial infections, and should be revised. For this indication, PICCs and percutaneous catheterization seem to be more suitable for infants weighing more than 5 kg [19] and may have had significantly better outcomes than tunneled Broviac catheters. [20, 21] We should also revise the surgical technique. It was reported that open external jugular vein catheter insertion is a safe, quick, and feasible alternative to internal jugular vein insertion. This new access offers comparable outcomes, reduced surgical morbidity, and improved hemostasis. [22]

In our study, the high rate of complications and the absence of a multidisciplinary protocol for this type of catheter management led to premature removal (<10 days) in more than half of the patients. The early removal of the catheter was correlated to complications, but it seems to be a consequence of complications and not a predictor. Also, the insertion of these tunneled catheters for perioperative patients, (who did not need prolonged venous access) can be implicated. In these cases, the risks were far higher than the benefits.

The results of this study are particularly relevant to the developing countries. This study showed that the Broviac catheter was widely requested even in an emergency context and for patients who did not need prolonged venous access, like infected patients (for antibiotics-therapy) and perioperative patients. This was the cause of the high rates of complications and the early removal of the Broviac catheter. To reduce morbidity, we recommend that the indications be followed and that patients be chosen carefully. Multidisciplinary written protocols and staff training are mandatory to acquire the necessary skills to manage these catheters and to reduce the cost of treating the complications. [23].

CONCLUSION

Our study has shown that Broviac catheter complications are a relatively common occurrence in our neonatal and pediatric population. Younger age and lower weight are factors predisposing to complications. The use of the Broviac catheter as an emergency venous access should be reconsidered due to the high risk of complications. To reduce Broviac catheter-related morbidity, indications should be carefully chosen, and long-term antibiotic therapy in severely infected patients should be avoided. Therefore, percutaneous catheters might be more suitable for these patients, whenever possible. A multidisciplinary written protocol should be established to manage these patients.

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REFERENCES

1. Thomas JH, MacArthur RI, Pierce GE, Hermreck AS. Hickman-Broviac catheters: Indications and results. Am J Surg. 1980; 140:791-6.
2. Pessa ME, Howard RJ. Complications of Hickman-Broviac catheters. Surg Gynecol Obstet. 1985; 161:257-60.
3. Perdikaris P, Petsios K, Vasilatou-Kosmidis H, Matziou V. Complications of Hickman-Broviac catheters in children with malignancies. Pediatr Hematol Oncol. 2008; 25:375-84.
4. Jarraya A, Triki Z, Guermazi J, Abdelkafi W, Galinski M, Karoui A. Femoral venous catheterization: a case of late femoral hematoma. Pan Afr Med J. 2014; 17:206.
5. Zhang JJ, Nataraja RM, Lynch A, Barnes R, Ferguson P, Pacilli M. Factors affecting mechanical complications of central venous access devices in children. Pediatr Surg Int. 2022; 38:1067-73.
6. Cesaro S, Corrò R, Pelosi A, Gamba P, Zadra N, Fusaro F, et al. A prospective survey on incidence and outcome of Broviac/Hickman catheter-related complications in pediatric patients affected by hematological and oncological diseases. Ann Hematol. 2004; 83:183-8.
7. Ammar S, Sellami S, Sellami I, Hamad AB, Hbaieb M, Jarraya A, et al. Risk factors of early mortality after neonatal surgery in Tunisia. J Pediatr Surg. 2020; 55:2233-7.

8. Ammar S, Sellami S, Sellami I, B. Hamad A, Jarraya A, Zouari M, et al. Management of esophageal atresia and early predictive factors of mortality and morbidity in a developing country. Dis Esophagus. 2019; 32:135.
9. Farou N, Lucas C, Olympia RP. School nurses on the front lines of healthcare: Children with medical devices—central venous access device malfunctions and infections. NASN School Nurse. 2021; 36:328-32.
10. Fritsch LM, Le M, Elrod J, Wössmann W, Vincent D, Reinshagen K, et al. Surgical experience affects the outcome of central venous access catheter implantation in children: A retrospective cohort study. J Pediatr Hematol Oncol. 2022; 8:10-97.
11. Moir D, Bodenham A. A narrative review of long-term central venous access devices for the intensivist. J Intensive Care Soc. 2018; 19:236-46.
12. Cesaro S, Cavaliere M, Pegoraro A, Gamba P, Zadra N, Tridello G. A comprehensive approach to the prevention of central venous catheter complications: results of 10-year prospective surveillance in pediatric hematology-oncology patients. Ann Hematol. 2016; 95:817-25.
13. Scott-Warren VL, Morley RB. Paediatric vascular access. BJA Educ. 2015; 15:199-206
14. Fratino G, Molinari AC, Parodi S, Longo S, Saracco P, Castagnola E, et al. Central venous catheter-related complications in children with oncological/hematological diseases: an observational study of 418 devices. Ann Oncol. 2005; 16:648-54.
15. Simon A, Graf N, Furtwängler R. Results of a multicentre survey evaluating clinical practice of port and Broviac management in paediatric oncology. Klinische Pädiatrie. 2013; 225:145-51.
16. Naik VM, Mantha SSP, Rayani BK. Vascular access in children. Indian J Anaesth. 2019; 63:737-45.
17. Blotte C, Styers J, Zhu H, Channabasappa N, Piper HG. A comparison of Broviac® and peripherally inserted central catheters in children with intestinal failure. J Pediatr Surg. 2017; 52:768-71.
18. Acosta CM, Tusman G. Ultrasound-guided brachiocephalic vein access in neonates and pediatric patients. Rev Esp Anestesiol Reanim (Engl Ed). 2021; 68:584-91.
19. Reddy SM, Soccorso G, Lawrence L, Bennett J, Jester I, Pachl M, et al. Ultrasound-guided percutaneous insertion of Broviac lines in infants less than 5kg: Prospective study of 100 consecutive procedures. . J Pediatr Surg. 2022; S0022-3468(22)00039-2.
20. Cotogni P, Mussa B, Degiorgis C, De Francesco A, Pittiruti M. Comparative complication rates of 854 central venous access devices for home parenteral nutrition in cancer patients: a prospective study of over 169,000 catheter-days. JPEN J Parenter Enteral Nutr. 2021; 45:768-76.
21. Merchaoui Z, Laudouar Q, Marais C, Morin L, Ghali N, Charbel R, et al. Ultrasound guided percutaneous catheterization of the brachiocephalic vein by small caliber catheter: An alternative to epicutaneo-caval catheter in newborn and premature infants. J Vasc Access. 2021: 11297298211034311.
22. Alshafei A, Tareen F, Maphango N, White D, O'Connor B, Sriparan T. Open tunneled central line insertion in children—External or internal jugular vein?. J Pediatr Surg. 2018; 53:2318-21.
23. Fitzgerald RK, Jennifer CY, Rajasekaran S, Curtis SE, Robertson DJ, Wincek JM, et al. Cost and safety of pediatric intensive care physician-placed broviac catheters. Pediatr Crit Care Med. 2014; 15:71-6.