Predictive Factors for Post-Operative Tracheostomy Requirement in Children Undergoing Surgical Resection of Medulloblastoma

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Clinical Study

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Abstract

Purpose: Medulloblastoma is the most common pediatric malignancy. Postoperative respiratory failure is an important complication in post-operative recovery of patients undergoing medulloblastoma resection. We aimed to identify factors predicting tracheostomy requirement in children post-operatively.

Methods: Retrospective chart review of all patients under 18 undergoing medulloblastoma resection from 2012 to 2020 at Namazi hospital was conducted.

Results: 45 patients (26%) needed tracheostomy after the operation. The most common indications were brainstem compression and absence of gag reflex prior to operation. Patients who had brainstem compression and infiltration by medulloblastoma, bilateral absence of gag reflex prior to operation, subtotal resection of tumor, and post-operative brainstem contusion were more likely to require tracheostomy. No statistically significant difference was observed between males and females and different ages.

Conclusion: The results show that if we prevent the invasion of the brainstem by the tumor and resect the tumors totally and accurately, tracheostomy, a highly costly and stressful post-operative complication can be prevented.

Introduction

Brain tumors are the leading cause of cancer-related mortality in children [1]. Medulloblastoma (MB) accounts for approximately 20% of all pediatric central nervous system (CNS) malignancies; making MB the most common malignant childhood brain tumor [2]. The current convention for treating Children With MB comprises a combination of tumor resection, craniofacial radio therapy, and chemotherapy based on the patient’s risk category, age, etc. [3]. Recently, a study was published on postoperative tracheostomy requirement in children undergoing surgery for posterior fossa tumors. Apart from this study, there is limited information on post-operative tracheostomy in children with MB undergoing surgical resection. Moreover, this study was limited by the number of MB cases. Only 65 MB patients were included in this study; solely one of them requiring tracheostomy.

The aim of the present study was to identify pre- and post-operative clinical and radiological factors associated with tracheostomy requirement in children with MB who underwent surgical resection. In the study by Goethe et al., having postoperative dysphagia, ependymoma or astrocytoma (as opposed to MB and atypical teratoid/rhabdoid tumor), and being younger were found to be linked to tracheostomy requirement in children undergoing surgery for posterior fossa tumors[4].

Methods And Materials

A retrospective chart review was conducted of all of the children who underwent initial MB resection between April 2012 and September 2020 at Namazi hospital, an academic tertiary referral center. This
study investigates patients under 18-years of age with posterior fossa tumors diagnosed as MB by pathology. Patients with incomplete medical records, equivocal tumor pathology, prior tumor resections, or age over 18 years were excluded from the study. Additionally, patients with any abnormality in chest X-ray obtained prior to the operation or those who were already tracheostomy-dependent were excluded from this study. The final extracted raw data was cross-examined by repeating the data collection for 20% of the patients randomly.

Demographic, clinical, pathologic, and outcome data were examined retrospectively. Variable investigated in this study for correlation with Tracheostomy tube insertion include the presence of hydrocephalus, application of ventriculoperitoneal (VP) shunt, brainstem compression and invasion (infiltration), whether MB tumors were located laterally in the cerebellopontine angle (CPA), preoperative bilateral absence of Gag Reflex (GR), presence of cystic degeneration in the tumor, whether the tumor was totally resected, presence of calcification in the tumor, postoperative brainstem contusion, age, and sex. This study was carried out between September and December 2020.

Data analysis was carried out using IBM SPSS Statistics version 16 (IBM Corp., Armonk, N.Y., USA). Comparisons were made using Chi-square tests, Fisher’s exact tests, or independent-samples t tests as appropriate. Comparisons were considered significant at the p < 0.05 level. Ethical approval was waived in view of the retrospective nature of the study and all the procedures being performed were part of the routine care.

Results

173 patients were included in this study, 68 females and 105 males (Table 1). Tracheostomy placement was carried out for 45 patients (26%). Brainstem compression (80%) and absence of GR (80%) followed by subtotal resection (62%) were the most common indications for tracheostomy.

Demographic Findings

There was no statistically significant difference between the age and sex of the patients and tracheostomy outcome in these patients.

Clinical and Radiologic Findings

Patients who had brainstem compression and infiltration by MB, bilateral absence of GR prior to operation, subtotal resection of the tumor, and post-operative brainstem contusion were more likely to require tracheostomy. The presence of cystic degeneration, calcification in the tumor, cervical invasion, and whether the tumor was located at CPA and the tracheostomy outcomes in these patients were not associated with tracheostomy requirement post-operatively.

Table 1. The relationship between patient demographics, pre- and post-operational presentations and tracheostomy in children undergoing surgical tumor resection.
| Mb patients who underwent surgery | No tracheostomy (n = 128) | Tracheostomy (n = 45) | P value |
|----------------------------------|---------------------------|----------------------|---------|
| Mean age, years (SD)             | 6.52 (4.024)              | 5.36 (4.739)         | .11     |
| Range                            | 1-17                      | 1-17                 |         |
| Sex                              |                           |                      | .81     |
| Female (68)                      | 51                        | 17                   |         |
| Male (105)                       | 77                        | 28                   |         |
| Cystic degeneration              |                           |                      | .08     |
| Present (55)                     | 36                        | 19                   |         |
| Not present (118)                | 92                        | 26                   |         |
| Calcification                    |                           |                      | 0.16    |
| Present (27)                     | 17                        | 10                   |         |
| Not present (146)                | 111                       | 35                   |         |
| Brainstem compression            |                           |                      | <.001   |
| Present (84)                     | 53                        | 36                   |         |
| Not present (89)                 | 75                        | 9                    |         |
| Brainstem infiltration           |                           |                      | <.001   |
| Present (44)                     | 20                        | 24                   |         |
| Not present (129)                | 108                       | 21                   |         |
| Cervical invasion                |                           |                      | 0.07    |
| Present (2)                      | 0                         | 2                    | (Fisher)|
| Not present (171)                | 128                       | 43                   |         |
| CP angle                         |                           |                      | 0.36    |
| Present (14)                     | 9                         | 5                    | (Fisher)|
| Not present (159)                | 119                       | 40                   |         |
| Gag reflex prior to operation    |                           |                      | <.001   |
| Present (86)                     | 50                        | 36                   |         |
| Not present (87)                 | 78                        | 9                    |         |
| Extent of resection              |                           |                      | <.001   |
|                          | Subtotal resection (66) | Total resection (107) |  
|--------------------------|------------------------|----------------------|  
| Subtotal resection (66)  | 38                     | 28                   |  
| Total resection (107)    | 90                     | 17                   |  
| Post operation brainstem contusion | <.001                  |                      |  
| Present (32)             | 8                      | 24                   |  
| Not present (140)        | 119                    | 21                   |  

**Discussion**

Our results show a remarkably high frequency of tracheostomies in patients whose GR was absent or brainstem was invaded, either compressed or infiltrated by the MB tumors. We found the incidence of tracheostomy requirement in our center for children undergoing MB tumor resection to be 26%, which is relatively high compared to previous studies (1.5%, 16%, and 6.4%)  

Tracheostomy placement may improve respiratory compromise caused by compression of the brainstem by MB tumor or resection operation. However, it is burdensome for the patient and family, challenges the clinical course and quality of life of the patients. A report suggests that it may adversely affect language development[7]. Moreover, tracheostomy placement can cause infection, tracheoinnominate fistula, stress on caregivers, place patients at risk for longer hospital stays and death, and impose a great financial burden on patients, families, and the healthcare system[7–10].

An important consideration in interpreting the results is that in our center the standard of care for MB resection involves VP shunt insertion two weeks prior to final operation. Although not everyone will be shunt-dependent for the rest of their lives, VP shunt insertion has several advantages. It provides a period of time for healing of the shunt insertions site. Moreover, there is a risk of upward herniation associated with ETV endoscopic third ventriculostomy in posterior fossa tumor. To be brief, VP shunt application is more favorable in our setting unless proven otherwise. The dominant approach in resecting MB tumors in our center is the midline transvermian posterior fossa approach is the approach practiced by pediatric neurosurgeons in resecting MB tumors in our center.

Postoperatively, we tend to keep the patients intubated for approximately two weeks. Although early tracheostomy is supported, we take a more conservative stance toward tracheostomy. It was noted before that the tracheostomy requirement in patients with brainstem tumors reflects the interruption of respiratory pathways located there[11]. After tumor resection, pressure on the nerves is reduced which might improve the lower cranial neuropathy and help the ventilation function to recover, particularly in pediatric patients. Besides, tracheostomy care is highly costly for the patients and not widely available. It is shown in the results that although the absence of GR is among the most common indications for tracheostomy. However, one-fourth of the patients with absent GR pre-operatively did not require tracheostomy after the operation. It is worth considering that in previous studies, 25% or more of the
patients were decannulated one year after the tracheostomy [4, 5]. Moreover, once the course of tracheostomy is finished, a second tracheostomy is rarely needed. Recannulation rate in the pediatric setting was measured at 6.5 % [12].

It should be considered that all of the tumors resected in our center were greater than 5 cm in diameter. It points to the ineffective system for screening brain tumors in Iran, resource scarcity, and the long waiting lists.

The lack of an association between the extension of the tumors to CPA and cervical invasion and tracheostomy requirement likely represents the limitation of small sample size and outcome of interest. In previous studies, it was suggested that younger patients were more likely to require tracheostomy. However, the statistical difference between the younger and older patients requiring tracheostomy was not statistically significant.

The greatest limitation of the present is the retrospective design of this investigation. This study does not follow the patients long after the operation. The final outcome of the tracheostomies, whether the patients were expired or decannulated, is not reported. However, the sample size of this study is exceptionally large. Although the patients were not followed long after the operations, valuable factors predicting the requirement of post-operative tracheostomy were included and analyzed. This study can give insight to practitioners and help them to make informed predictions about their needs, patients who may benefit from early tracheostomy, the outcome of the operations, and reduce intubation-associated trauma and time on mechanical ventilation.

Finally, by comparing the results of the present study with similar reports, it becomes clear that an effective screening system is of utmost importance. If the tumors are diagnosed earlier and at a lower size, brainstem compression, infiltration and other indications for tracheostomy are less likely to develop. By doing so, we can improve the outcome of MB tumor patients and prevent tracheostomy which is highly burdensome financially, physically, and emotionally.

**Abbreviations**

Medulloblastoma (MB)

Central Nervous System (CNS)

Ventriculoperitoneal (VP)

Cerebellopontine Angle (CPA)

Gag Reflex (GR)

Endoscopic third ventriculostomy (ETV)

External ventricular drain (EVD)
Declarations

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Competing interests

The authors have no relevant financial or non-financial interests to disclose.

Availability of data and material

All data generated or analyzed during this study are included in the final published article.

Code availability

Code sharing was not applicable to this article as no codes were generated or analyzed during the current study.

Authors' contributions

This study was designed by Mohammad Sadegh Masoudi, Sina Zoghi, and Reza Taheri. The data was collected by Reza Taheri and Mohammad Sadegh Masoudi. Data curation and analysis were conducted by Sina Zoghi. The final manuscript was written and edited by Sina Zoghi and Mohammad Sadegh Masoudi. All contributing authors approved the final manuscript.

Ethical approval and consent to participants

Ethical approval was waived in view of the retrospective nature of the study and all the procedures being performed were part of the routine care. Ethical consent for participation and publication was collected when the operations were conducted.

References

1. Pollack IF (1994) Brain Tumors in Children. N Engl J Med 331:1500–1507. https://doi.org/10.1056/NEJM199412013312207

2. Louis DN, Perry A, Reifenberger G, et al (2016) The 2016 World Health Organization Classification of Tumors of the Central Nervous System: a summary. Acta Neuropathol 131:803–820. https://doi.org/10.1007/s00401-016-1545-1

3. Juraschka K, Taylor MD Medulloblastoma in the age of molecular subgroups: a review. J Neurosurg Pediatr PED 24:353–363. https://doi.org/10.3171/2019.5.PEDS18381

4. Goethe EA, LoPresti MA, Gadgil N, Lam S (2020) Predicting postoperative tracheostomy requirement in children undergoing surgery for posterior fossa tumors. Child’s Nerv Syst 36:3013–3019. https://doi.org/10.1007/s00381-020-04605-7
5. Tomita T, Grahovac G (2015) Cerebellopontine angle tumors in infants and children. Childs Nerv Syst 31:1739–1750. https://doi.org/10.1007/s00381-015-2747-x

6. Totapally BR, Shah AH, Niazi T (2018) Epidemiology and short-term surgical outcomes of children presenting with cerebellar tumors. Clin Neurol Neurosurg 168:97–101. https://doi.org/10.1016/j.clineuro.2018.02.038

7. Fauroux B, Leboulanger N, Roger G, et al (2010) Noninvasive positive-pressure ventilation avoids recannulation and facilitates early weaning from tracheotomy in children*. Pediatr Crit Care Med 11:

8. Spataro E, Durakovic N, Kallogjeri D, Nussenbaum B (2017) Complications and 30-day hospital readmission rates of patients undergoing tracheostomy: A prospective analysis. Laryngoscope 127:2746–2753. https://doi.org/https://doi.org/10.1002/lary.26668

9. Kubo A, Kurtovich E, McGinnis M, et al (2020) Pilot pragmatic randomized trial of mHealth mindfulness-based intervention for advanced cancer patients and their informal caregivers. Psychooncology. https://doi.org/10.1002/pon.5557

10. Joseph RA, Goodfellow LM, Simko LMVO-33 Parental Quality of Life: Caring for an Infant or Toddler with a Tracheostomy at Home. Neonatal Netw 86–2014. https://doi.org/10.1891/0730-0832.33.2.86

11. Qureshi Al, Suarez JI, Parekh PD, Bhardwaj A (2000) Prediction and timing of tracheostomy in patients with infratentorial lesions requiring mechanical ventilatory support. Crit Care Med 28:

12. Mahadevan M, Barber C, Salkeld L, et al (2007) Pediatric tracheotomy: 17 year review. Int J Pediatr Otorhinolaryngol 71:1829–1835. https://doi.org/https://doi.org/10.1016/j.ijporl.2007.08.007