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Total laryngectomy in neonate with laryngeal sarcoma: perioperative management: Case report

Laringectomía total en un neonato con sarcoma laringeo congénito: Manejo perioperatorio; reporte de un caso y revisión de la literatura

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ABSTRACT

Newborn airway related diseases are one of the biggest challenges that an anesthesiologist can face during his medical practice. This case report describes a complete airway obstruction in a neonate with a laryngeal sarcoma who underwent various diagnostic procedures, finally receiving a total laryngectomy as part of his oncological treatment. We document the perioperative care during the laryngectomy, a procedure that has not yet been reported in literature to the date. We share our experience on how to confront such challenge and review the current literature on laryngeal cancer in the pediatric population.

Key words: Neonate, children malignancy, perioperative management.

RESUMEN

La patología relacionada con la vía aérea en el recién nacido es uno de los grandes retos a los que se enfrenta un anestesiólogo; en este reporte de caso se presenta un neonato con obstrucción completa de la vía aérea por un fibrosarcoma laríngeo sometido a varios procedimientos diagnósticos bajo anestesia general y finalmente se le realiza una laringectomia total. Como parte de su manejo oncológico. Se documenta el manejo perioperatorio de la laringectomia; procedimiento hasta el momento no reportado en neonatos, se comparte la experiencia de enfrentar un reto complejo y se hace una revisión de literatura del cáncer laríngeo en la población pediátrica.

Palabras clave: Neonato, cáncer laríngeo, manejo perioperatorio.

Introduction

Globally, head and neck cancers are reported to be a relatively frequent condition between the fifth and seventh decades of life, being rare in those under 40 years of age. Its incidence is 650,000 cases per year with an annual death rate of 300,000 for the adult patient[1]. However, laryngeal carcinoma is an extremely rare disease among the pediatric ages. The first case was reported in 1868 in a 3-year-old child. Head and neck malignant neoplasms represent 2 to 10% of solid tumors during the pediatric ages but laryngeal carcinoma is as low as 0.1% of them all. Most commonly described laryngeal neoplasms in the pediatric population are squamous cell carcinoma and rhabdomyosarcoma. Other malignant laryngeal tumors include minor salivary gland carcinoma, primitive neuroectodermal tumors (PNET) and metastatic lesions.

First reports in literature describe that Squamous cell carcinoma develops when a benign laryngeal papilloma undergoes

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radiation[2]. There are few reported cases for mesenchymal cell tumors, being rhabdomyosarcoma the most frequently described, followed by synovial sarcoma, Ewing´s sarcoma, fibrosarcoma and mixed sarcoma. In 1941, Dr. Rigby and Dr. Holinger from the Children Memorial Hospital in Chicago reported the one and only neonatal laryngeal fibrosarcoma described to date. There´s no consensus on how to treat the pathology in an adequate manner[3],[4],[5].

We report the perioperative management of a neonate with a congenital laryngeal fibrosarcoma who was taken to a total laryngectomy as part of the global management of his disease and review laryngeal cancer in the pediatric population. There are no current available reports of the perioperative management for a total laryngectomy in neonates.

Case report

A 37 + 4 weeks natural born neonate with normal pre-natal conditions debuted with severe stridor at his fourth day of life. In a fiber nasolaryngoscopy, a tumor occluding almost 100% of the airway in the glottic and supra glottic region was found. Biopsies were taken in a laryngeal micro-endoscopy, performing then a partial resection of the tumor. Later, the newborn presented again with a complete airway obstruction, needing a new orotracheal intubation. Biopsies, although not concluding, reported a fusocellular tumor compatible with a rhabdomyosarcoma. Finally, the patient was transferred to our institution for further investigations and a multidisciplinary management.

An initial neck/thorax CT reported a diminished airway (99%) caliber in the supra, epi and glottic regions. Supraglottic structures were not easily identified and the vallecules and piriform sinuses were completely obliterated. The airway began to have a near normal caliber at the height of the thyroid gland. Simple and contrasted MRI described a tumor-like mass involving the laryngeal region in the supraglottic, glottic and subglottic region, with no extralaryngeal extension.

The case was then discussed in a medical staff, in which the decision was to perform a laryngeal microsurgery to take new biopsies. The samples showed a congenital laryngeal fibrosarcoma, so in a last meeting the total laryngectomy was decided. The pre-anesthetic evaluation was done for total laryngectomy. We had a male patient of 1 month old weighing 4,100 grams. Parents were explained the scheduled surgical procedure, risks and complications, they understood, accepted and gave their consent for their child's surgery and blood transfusion if necessary. A unit of fresh and leuko reduced red blood cells was reserved. Instructions about enteral route were given (Table 1).

The surgical procedure was performed with basic ASA monitoring, oropharyngeal temperature, diuresis, and invasive arterial pressure (radial artery). The intravascular volume and allowable blood loss were calculated (320 and 70 ml respectively) according to patient´s weight and age.

Two peripheral venous lines were cannulated with a 24 catheter in addition to a 4 Fr bilumen central venous catheter. Temperature maintenance was carried out with a convective air blanket, sterile plastic covering the entire surface of the patient, warm intravenous fluids, and a respiratory circuit with warm and humid air.

The airway was initially patent through the oro-tracheal route and later through a surgical stoma at the tracheal level with a number 3.5 tube with balloon. The ventilatory strategy used was pressure-controlled mechanical ventilation with guaranteed volume (autoflow) with a $FI0_2$ between 60%-70%. The anesthetic maintenance was done with Sevoflurane (1 MAC) and fentanyl infusion (3 mcg/kg/h) and ketamine (30 mcg/kg/min). Maintenance of intravenous fluids was performed with dextrose at 10%, replacement of blood losses initially with balanced solution (plasmalyte) and later with red blood cells when the permissible blood losses were exceeded. Maintenance of muscle relaxation was performed with rocuronium (0.6 mg/kg) and antibiotic prophylaxis with ampicillin sulbactam (50 mg/kg). During the intraoperative period, it was necessary to administer calcium gluconate due to hypocalcemia evidenced in the arterial gases. Calcium gluconate 100 mg/kg was administered by the central line.

In the intraoperative period, due to the small size of the structures and due to surgical manipulation, there was inadvertent mobilization of the 3.5 tube located in the tracheal stoma towards the outside or towards the right main bronchus on several occasions. Additionally, at the beginning of the surgical procedure, an increase in the difference of $PaCO_2$ and $ETCO_2$ was detected early in the initial arterial gases due to the dead space produced by the tube located in the tracheal stoma, which was corrected.

At the end of the surgical procedure, the tracheal tube was replaced by a Shiley cannula tracheostomy (4.0), verifying adequate bilateral thoracic expansion and adequate oxygenation and ventilation.

The anesthetic time was 5 hours 30 minutes, and the surgical time was 4 hours 30 minutes. There were no surgical or anesthetic complications during laryngectomy. Intra-operative bleeding was calculated as 120 ml (higher than the calculated allowable blood losses). A total of 450 ml of crystalloids were administered (plasmalyte plus metabolic flow with dextrose) and 60 ml of red blood cells (15 ml/kg). The patient was trans-

Table 1. The pre-surgical admission reported

Parameter	Result
Hemoglobin g/dL	10
Hematocrit %	30
Platelets mm^3	315,000
Coagulation studies	TP: 12.7/11.4 INR:1.1 TPT:34.57/31.5 Ratio 1:1
Blood chemistry meq/L	Calcium: 9.8 Chloride: 102 Sodium: 134 Potassium: 4.46 Magnesium: 1.85
Creatinine mg/dL	0.47

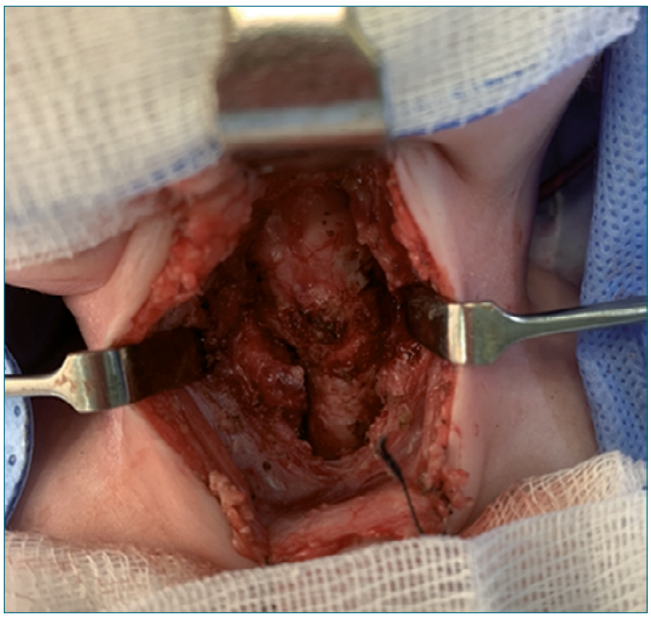

Figure 1. Larynx dissection.

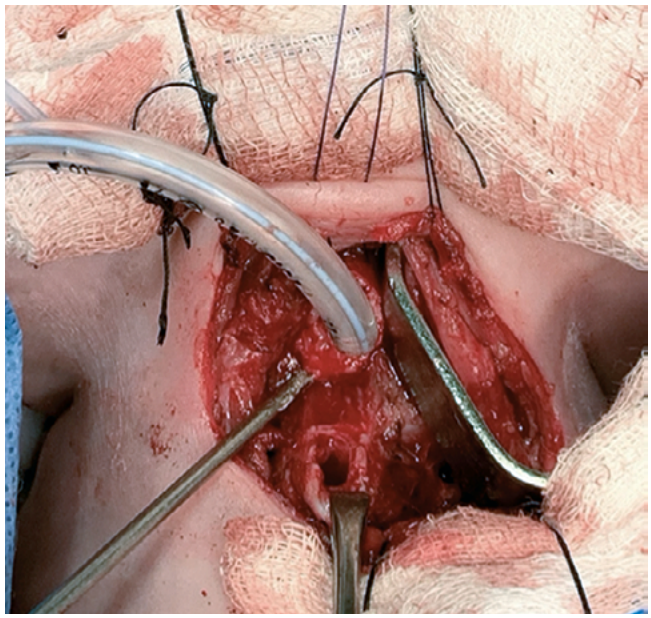

Figure 2. Orotraqueal tube in traqueal stoma.

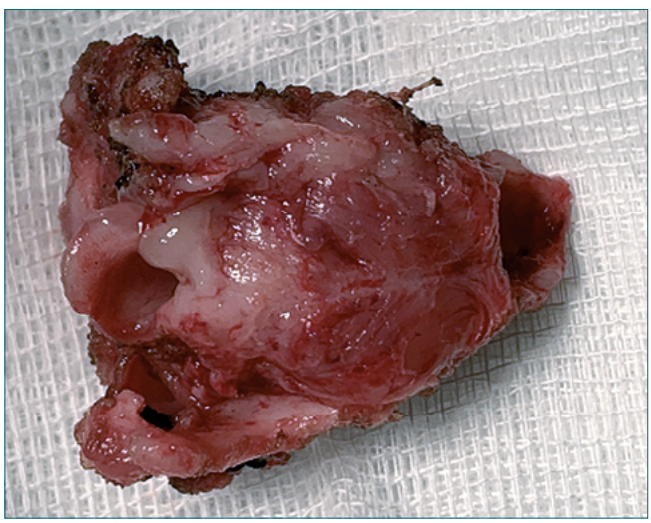

Figure 3. Larynx.

ferred to the neonatal intensive care unit with a patent tracheostomy, he was hemodynamically stable with adequate parameters of oxygenation, ventilation, and perfusion. Final arterial gases reported lactic acid of 1.4 mmol/L, ions and hemoglobin were normal for his age. The resected larynx was sent for a pathological anatomy study. The post-operative recovery was very satisfactory, and he completed the management of laryngeal cancer with chemotherapy indicated by the oncology service (Figure 1-2-3).

Discussion

In children and adolescents, malignant tumors of the larynx are rare. Institutional reviews and case reports in patients under 15 years of age have shown that laryngeal carcinoma accounts for less than 0.1% of malignant head and neck tumors[6],[7],[8],[9],[10].

Recent studies indicate that many malignant tumors today are derived from mesodermal tissue, in contrast to initial reports in the literature of squamous cell tumors related to irradiation of benign lesions such as juvenile laryngeal papillomatosis.

Experience with laryngeal tumors in children is very scarce and has been limited to case reports and institutional reviews[11],[12].

Children may present with hoarseness, dysphagia, stridor, or upper airway obstruction. The severity of the clinical picture depends on the degree of airway obstruction caused by the tumor. Diagnosis is completed with endoscopic evaluation of the airway, airway biopsy, and other studies including computed axial tomography and magnetic resonance imaging of the neck to assess the extent of the disease. The definitive diagnosis of laryngeal lesions is made by endoscopic findings and biopsy with histopathological examination[13].

The first case of laryngeal cancer (squamous cell carcinoma) in a 3-year-old boy was reported by Rehn in 1868. In 1969, Jones and Gabriel conducted a literature review with 99 cases of laryngeal carcinoma in patients under 20 years.

Subsequently, Gindhart et al in 1980, in a review of the literature, found 38 publications with 54 reported cases of squamous carcinoma of the larynx in children under 15 years of age since 1968. Of the reported cases, 13.4% were in patients between 1-5 years, 23% between 6-10 years, and 66.6% in patients between 11-15 years. It should be noted that there were no cases reported in patients under 1 year of age[14],[15].

Certain subgroups of head and neck malignancies are significantly less common in pediatric patients, in particular sarcomas. Sarcomas account for approximately 1% of all head and neck malignancies.

Soft tissue sarcoma represents a diverse class of malignancies. They can also be divided by histological subtypes such as

rhabdomyosarcoma, chondrosarcoma, Ewing's sarcoma and fibrosarcoma among others; each with a different biological behavior.

The most common histological subtype of childhood sarcoma is rhabdomyosarcoma, which accounts for approximately 4.5% of all pediatric malignancies with an incidence of 4.5/1,000,000. The distribution of the age of presentation is bimodal: the first peak is between the ages of 2 and 6 years and the second peak between the ages of 10 and 18 years. Among them, the incidence of laryngeal sarcoma is less than 0.1%[16],[17].

Advances in cancer treatments over the past decades have substantially improved sarcoma outcomes. Surgery was the only therapy available in the early 20th century associated with very poor outcomes, however this has changed with the advent of multimodal therapy[18].

Levi et al., conducted a systematic review of the literature of cases of laryngeal sarcoma in children from 1980 to 2019. The objective of the study was to evaluate the histological types and the treatment received in patients with laryngeal sarcoma in children up to 16 years of age. A total of 29 articles (37 patients) met the inclusion criteria for the study analysis. The median age identified in the systematic review was 11 years with a range of 0 to 16 years. 79.4% of the patients were men and 20.6% were women. The most common histological subtype of sarcoma was rhabdomyosarcoma, present in 69.4% of the cases. 19.4% of the patients were diagnosed with synovial sarcoma. The rest of histological types such as chondrosarcoma (2.8%), Ewing's sarcoma (2.8%), fibrosarcoma (2.8%) and mixed sarcoma (2.8%) were diagnosed in 1 patient each. The different locations of the tumor were: supraglottic (62.1%), glottic (17.2%), and subglottic (20.7%).

Treatment of these tumors was generally defined by size, location, and degree of malignancy. The most common treatment strategy was multimodal (76%) consisting of surgery with chemotherapy and/or irradiation. The patients who received a single treatment modality were distributed as follows: surgery (17.2%), chemotherapy (3.4%), radiotherapy (3.4%). On the other hand, the patients who received bimodal therapy were distributed as follows: chemo and radiotherapy (17.2%), surgery and chemotherapy (10.3%), surgery and radiotherapy (20.7%) and the rest of the patients were treated with surgery, chemotherapy, and radiotherapy (27.6%). Among all patients who underwent initial removal or ablation surgeries, 50% underwent total laryngectomy, while the other 50% had laryngeal preservation procedures such as partial laryngectomy or endoscopic resection of the laryngeal lesion[19].

"Children are not small adults". This commonly mentioned phrase could not be more relevant than in the care of our smallest and most fragile patients such as patients of a short age of life. Advances in pediatric anesthesia have contributed to improved outcomes and survival in newborns requiring low to high complexity surgical interventions. The physiology of the newborn is characterized by a high metabolic rate, a decreased cardiopulmonary reserve, and a decrease in kidney function, among others. The immaturity of all organs and systems make these patients especially vulnerable during the perioperative period with a high risk of morbidity and mortality compared to other older pediatric and adult patients.

Recent research on perioperative mortality has considered the interaction of patient comorbidities with the intrinsic risk of the surgical procedure. Nasr et al. identified 5 main comorbid conditions that affect outcomes and increase mortality: patient weight less than 5 kg, ASA III classification or greater, ventilatory support, preoperative sepsis, and inotropic support[20],[21].

It should be noted that our patient had 3 of those risks factors: previous ventilatory support, weight less than 5 kg, and ASA III.

The approach of complex pathology of the airway in neonates is a great challenge for anesthesiologists considering the limited literature on the matter, because generally airway procedures are meant for other pathologies such as: laryngomalacia, subglottic cysts, subglottic hemangiomas, laryngeal cleft, subglottic stenosis, laryngeal papillomatosis, tracheomalacia.

The management of our highly complex patient was possible due to the multidisciplinary approach and the preparation prior to the procedure of the otorhinolaryngology, anesthesia, and critical care group[22],[23],[24],[25],[26].

From the anesthetic point of view, the preoperative evaluation, determination of the surgical risk, explanation of the informed consent with the risks to the parents and the confirmation of the reservation of blood products were key to the good outcome of the case.

During the intraoperative period, the preparation of the operating room with the devices for airway management, canalization of the necessary vascular accesses, adequate hemodynamic, gasimetric and temperature monitoring, appropriate mechanical ventilation, availability of medications, intravenous fluids and blood products and the availability of critical postoperative care were fundamental for the success in the management of this very vulnerable patient.

The risks associated with the critical points of total laryngectomy surgery reported in adults were considered, such as: cervical incision, performance of the tracheal stoma, hemorrhage secondary to injury to neck and thyroid vessels, thyroid and thymus injury, pneumothorax, pneumediastinum, and pneumopericardium risks, endotracheal tube balloon damage, need to change the tracheal tube for another more proximal tube with the imminent risk of loss of the tracheal lumen, obstruction of the tube with blood or secretions, mono bronchial intubation, accidental extubation or kinking of the tube causing difficulties for ventilation[27],[28],[29].

In addition to basic ASA monitoring, invasive blood pressure monitoring was justified because of the need for taking serial gases and continuous blood pressure monitoring. Even though total laryngectomy in an adult patient does not mean a high risk of bleeding, in a neonate with a lower intravascular volume in relation to weight, bleeding leads to a high risk of hemodynamic instability, shock, and electrolyte disturbances. During the intraoperative period, the monitoring and maintenance of temperature was guaranteed, considering the high risk of hypothermia in this age group.

Close monitoring of ventilatory parameters was performed by monitoring mechanical ventilation, arterial gases, and by measuring the difference in $PaCO_2$ and $ETCO_2$ to detect increased dead space due to the nature of the procedure and the impact of this on the physiology of the patient, in addition to the risk of recurrent and inadvertent mobilization of the tracheal tube due to surgical manipulation.

Furthermore, the patency of the endotracheal tube was

continuously monitored due to the risk of obstruction with blood and/or secretions in a small-caliber tracheal tube. During normal circumstances, the flow through the airway is laminar and follows the Hagen - Poiseuille principle; flow velocity is directly proportional to the pressure gradient and the transverse diameter of the airway. A narrow airway causes turbulent airflow and a higher-pressure gradient, an aspect of great importance due to the risk of difficult ventilation during the intraoperative period[30].

Careful administration of fluids, especially to avoid overload is imperative for younger children. The prevention of hypoglycemia is essential in this group of patients due to their young age with high metabolic consumption and low glycogen reserve; therefore, a perioperative metabolic flow must be ensured. Due to the few permissible blood losses in neonates, it is usually necessary to perform transfusion of blood products; the risks that this entail, such as hyperkalemia, hypocalcemia, volume overload and dilution of coagulation factors must be considered.

Risk reduction strategies include ordering fresh and washed red blood cells, administering diuretics prophylactically (furosemide) to prevent hypervolemia, intravenous calcium in the presence of hypocalcemia and monitoring for signs of hyperkalemia on the electrocardiogram.

One of the most challenging tasks an anesthesiologist can face is providing safe and quality anesthesia for surgery on a newborn. It requires a deep understanding of the anatomy, physiology, and rapidly changing pathology of the neonate as well as the pharmacokinetics and pharmacodynamics of the administered drugs. This knowledge must be incorporated into a well-programmed anesthetic care plan, likewise, manual skills and ongoing experience with the unique challenges posed by neonates are essential for optimal clinical outcomes with these highly vulnerable patients.

Conclusions

End laryngotracheal surgery in newborns, infants and children poses a great challenge for both the anesthesiologist and the otolaryngologist.

The diameter of the airway, the smaller size of the nervous and vascular structures, the small weight, the immaturity of all organs and systems, especially in neonates, and the great variability of pathological lesions require close collaboration between the anesthesia and surgical team to provide optimal surgical conditions and ensure adequate oxygenation, ventilation and perfusion during the perioperative period and thus obtain a good surgical result vital for the prognosis of the disease.

Due to the infrequency of laryngeal carcinoma in children, there is no consensus on the most relevant therapy.

Treatment of laryngeal carcinoma in pediatric patients presents several difficulties; it is difficult to inform parents and relatives about the disease, treatment decisions, and its late consequences.

It is of great importance to report these cases because the reviews of clinical cases in the literature are not numerous enough to make treatment decisions due to the lack of sufficient information on staging, management, and results. Accurate diagnosis and detection of an early stage of the disease are essential for the treatment of pediatric laryngeal carcinoma.

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