

Ex-Utero Intrapartum Treatment for airway management in congenital giant neck masses

Técnica EXIT como manejo de la vía aérea en masas gigantes congénitas de cuello

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What do we know about the subject matter of this study?

The EXIT technique has shown to be a safe and effective approach in congenital conditions with risk of perinatal asphyxia due to compression of the airway that decreases morbidity and mortality. It requires a timely diagnosis and a multidisciplinary team to carry it out.

What does this study contribute to what is already known?

This research contributes to the standardization of this technique in middle-income countries.

Abstract

Introduction: Congenital head and neck masses are associated with perinatal asphyxia and brain injury, increasing the risk of death. The EXIT (Ex Utero Intrapartum Treatment) technique consists of ensuring the newborn's airway while is still receiving placental support. This technique has not been standardized in developing countries. **Objective:** To describe the clinical outcomes of two infants who underwent the EXIT technique. **Clinical Case:** We present two cases, one with lymphatic malformation diagnosed at 20 weeks of gestational age (WGE) and the second one, a preterm newborn with thyromegaly and polyhydramnios, diagnosed at 35 WGE. In both cases, during the C-section, the EXIT technique was performed with a team of a neonatologist, a gynecologist, an anesthesiologist, a pediatric surgeon, an otolaryngologist, a nurse, and a respiratory therapist. In both patients, the neonatologist achieved to secure the airway through orotracheal intubation at the first attempt. In the first case, lymphatic malformation was confirmed and received sclerotherapy, and the second one was diagnosed with congenital hypothyroidism which

Keywords:

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was managed with levothyroxine. The patients needed invasive mechanical ventilation for 7 and 9 days, respectively, and were discharged without respiratory complications. **Conclusions:** In these patients, the EXIT technique was a safe procedure, carried out without inconvenience. A multidisciplinary approach and the availability of a neonatal intensive care unit are needed to reduce potential complications and ensure postnatal management. Timely prenatal diagnosis is essential to perform this technique.

Introduction

As part of the congenital high airway obstruction syndrome (CHAOS), congenital head and neck masses are associated with high mortality and hypoxic-ischemic brain injury in newborns (NBs)^{1,2}. The most frequent causes are lymphatic malformations, which occur in 1:1,775 live births³.

Congenital head and neck masses can cause severe compression and distortion of the airway, leading to high difficulty in ensuring ventilatory support at birth, increasing the risk of death or complications due to perinatal hypoxia. In order to prevent these outcomes, the EXIT technique (ex utero intrapartum treatment) has been proved as a safe procedure for intervening in the patient's airway to avoid altering the tissue perfusion and oxygenation of the NB. This technique requires a multidisciplinary approach including neonatologists, otolaryngologists, anesthesiologists, obstetrician-gynecologist, pediatric surgeons, nurses, and respiratory therapists trained in maternal-fetal medical care. Therefore, it is essential prenatal diagnosis through MRI⁴.

The EXIT technique, described by Norris et al in 1980⁵, consists of securing the airway through orotracheal intubation (OTI), rigid bronchoscopy or tracheostomy (according to the severity of the obstruction), with no interruption of maternal-fetal circulation through the placental support which controls the respiratory and cardiac functions⁶⁻⁸. Once the airway is secure, the umbilical cord is cut and the mother and NB are treated separately according to their requirements.

This technique was initially recommended for the management of tracheal occlusion in NB with severe congenital diaphragmatic hernias^{9,10} but was quickly extrapolated to patients with CHAOS or congenital lung lesions¹¹.

Although Cruz-Martinez et al described the EXIT technique in Mexico in 2015¹², this procedure has not been completely standardized in middle-income countries. The objective of this paper is to describe the clinical outcomes of two patients who were managed with the EXIT technique and to review the development of this procedure in a tertiary referral hospital in southwestern Colombia.

Clinical Case

Case 1

Female NB, first child of a 21-year-old mother, with prenatal care started at 9 weeks of gestation. At week 20, the ultrasound scan detected a cyst-like cervical mass. Subsequently, an MRI showed a large mass that affects the neck and the right side of the chest, extending between the ear and the right thoracic area, of 12 x 15 cm approximately (Figure 1a). In the 36th week of pregnancy, a C-section was performed and the EXIT technique was used during that procedure. The neonatologist could secure the airway through OTI on the first attempt (Figure 1b), and the patient was then transferred to the neonatal ICU.

Postnatal MRI showed findings consistent with lymphatic malformation, therefore, we initiated sclerotherapy with adequate clinical response (Figure 1c). On day 7 of life, the OTI was withdrawn and on day 16, ventilatory support was also discontinued and the patient was discharged on day 21 of life without respiratory complications.

Case 2

Male NB, second child of a 17-year-old mother, with prenatal care that started at 30 weeks of gestation. At week 33, an ultrasound scan detected mild polyhydramnios. At week 35, a neck mass with marked vascularization of around 4x3 cm was observed in the anterior region of the neck, from the sternum to the maxilla on the left side, causing compression of the trachea and esophagus. A C-section was indicated at 36 weeks of gestation and the EXIT technique was performed during this procedure. The neonatologist achieved OTI on the first attempt, and then the patient was transferred to the neonatal ICU for postnatal care.

MRI showed a 5x3 cm lesion causing a lobe-shaped mass effect in the pharyngeal mucosal space of the neck in the anterior region surrounding the trachea, the esophagus, and displaced bilaterally the jugular vein and carotid artery in a lateral and posterior direction without compressing the airway (Figure 2). The TSH levels presented increased T3 and decrease T4, confirming the diagnosis of congenital hypothyroidism which, associated with the significant increase in gland

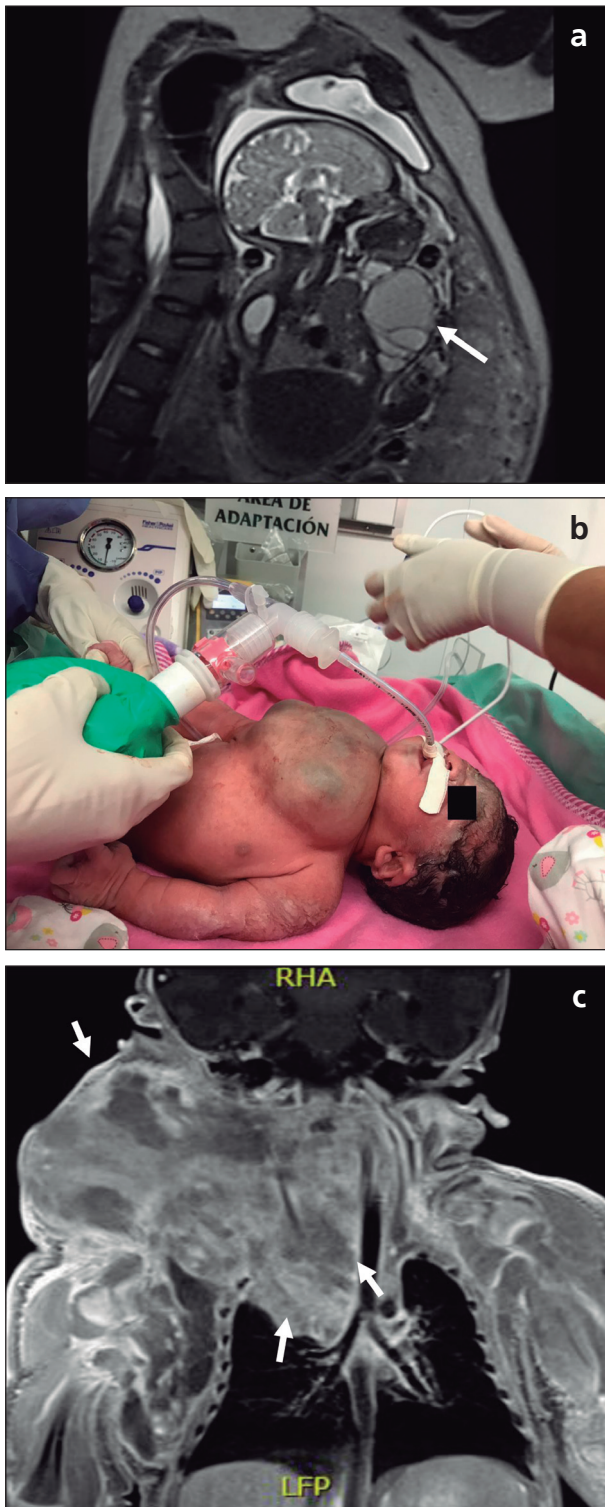


Figure 1. a) Fetal magnetic resonance imaging (MRI) shows a large multicystic mass affecting the right neck, the supraclavicular fossa, the axillary fossa and the posterolateral wall of the right chest compatible with veno-lymphatic vascular malformation (white arrow), without evidence of airway compression; **b)** Photograph of a newborn with a veno-lymphatic malformation in the neck and left anterior chest; **c)** Postnatal MRI shows a large multicystic mass, affecting the posterior cervical, carotid and right retropharyngeal space, extending to the mediastinum and to the anterior and posterior right chest wall (white arrows).



Figure 2. Postnatal MRI sagittal section shows important thyromegaly/goiter.

volume, defines the probable diagnosis of thyroid dys-hormonogenesis. Levothyroxine was indicated which shows adequate clinical response.

On day 9 of life, the orotracheal tube was removed and the patient continued with non-invasive mechanical ventilation until the 12th day. He was discharged at 14 days of life without respiratory complications and with outpatient care.

Discussion

In our patients, airway obstruction puts them at high risk of severe hypoxia or death. The implementation of the EXIT technique was the safest and most efficient option to maintain tissue perfusion to reduce the risk of complications underlying neonatal asphyxia.

The EXIT technique was initially described in patients with tracheal occlusion but its use has rapidly spread including growing pulmonary malformations as congenital cystic adenomatoid malformations that can compress the remaining normal lung tissue¹³, laryngeal membrane, tracheal atresia or stenosis, thoracic abnormalities, among others. Table 1 shows such malformations^{14,15}.

The EXIT technique should be performed under general anesthesia to ensure uterine hypotonia and thus allow adequate placental circulation, in order to

reduce the risk of umbilical cord prolapse, and placental abruption¹⁶. This procedure requires a trained multidisciplinary team and the availability of a neonatal ICU⁸. Also, it has to be planned based on the needs of each patient and therefore early diagnosis is essential for its implementation.

In our cases, one of them had late prenatal care which increases the risk of complications due to its implementation without prior planning. Table 2 describes the functions of each participating team member.

Figure 3 describes the algorithm of the EXIT technique. The surgical incision can be either midline or lower-transverse (Pfannenstiel incision) or, following hysterotomy, lower-transverse (Keer incision) where the fetus is partially delivered (head, upper chest, and at least one upper limb)⁴. As it is necessary to avoid work of breathing and body movements to achieve orotracheal intubation, it may be necessary the use of fetal anesthesia immediately after pulling out an upper limb, intramuscularly in the deltoid^{17,18}. The rest of the body remains within the uterine cavity.

It is recommended to infuse Hartmann solution at 37°C continuously to preserve the volume and temperature of the uterus, and the use of an oximeter in the upper extremity to monitor heart rate and O₂ saturation¹².

Under optimal conditions, fetal oxygenation from the placenta can be extended up to 150 minutes¹⁹. OTI is the main measure of management. In the event of OTI failure, bronchoscopy and tracheotomy are the second and third management options, respectively^{20,21}.

In some cases, partial or complete resection of the mass will be necessary to free the trachea from external compression to allow intubation or tracheotomy and therefore access to the airway²². In our patients, the

neonatologist was able to secure the airway with OTI on the first attempt.

Once the airway is secure, the anesthesia is discontinued, the umbilical cord is clamped and cut, and the rest of the body is delivered. Finally, the afterbirth is carried out by administering uterotonic drugs to close the uterine and abdominal walls¹².

It should be noted that the EXIT technique is a transitional measure to ensure patient ventilation, therefore, the cervical mass that generates or can potentially cause airway obstruction must be timely addressed. MRI is the best tool to identify more clearly the patient's condition since it allows differentiation of the altered tissue from normal one²³. In the cases of this

Table 1. Indications to implement the EXIT technique.

- Clip removal in cases of Congenital Diaphragmatic Hernia (CDH)⁹
- Ensure airway:
 - Extrinsic obstructions (teratomas, lymphangiomas, goiter)^{7,27}
 - Intrinsic airway obstructions (CHAOS, laryngeal or tracheal atresia)
- Extract intrathoracic masses:
 - Congenital Cystic Adenomatoid Malformation (CCAM)
 - Lung sequestration
 - Teratomas²⁸
- Make the connection to Extracorporeal Membrane Oxygenation (ECMO) in diaphragmatic hernias²⁹
- Siamese separation
- Other indications³⁰:
 - Ultrasound-guided percutaneous puncture during the EXIT procedure in giant cervical lymphangiomas
 - Reverse fetal tracheal occlusions in CDH
 - Chest abnormalities: massive pleural effusions and giant CCAM
 - Elimination of thoraco-amnionitic shunt. Thoracotomies and lung lobe resections
 - Channeling of central vessels prior to ECMO

Table 2. Interdisciplinary team for the EXIT technique

Specialty	Functions
Anesthesiology	Anesthesia and relaxation of the mother to maintain adequate perfusion of the fetus and newborn anesthesia
Gyneco-obstetrics	Cesarean, extraction of newborn head and right arm without interruption of placental circulation, allowing access to the fetal airway
Neonatology	- Initial approach of newborn airway by orotracheal intubation (OTI), subsequent handling of ventilation and oxygenation of the newborn - Comprehensive newborn care
Otorhinolaryngology	- Bronchoscopy in case of OTI failure - Performing a tracheostomy in case of OTI failure by bronchoscopy
Pediatric Surgery	Surgical access to the airway through dissection or partial removal of the obstructive lesion
Respiratory therapy	Comprehensive care of the newborn's airway
Nursing, nursing assistant, scrub nurse	- Mother and newborn care - Support to the rest of the team

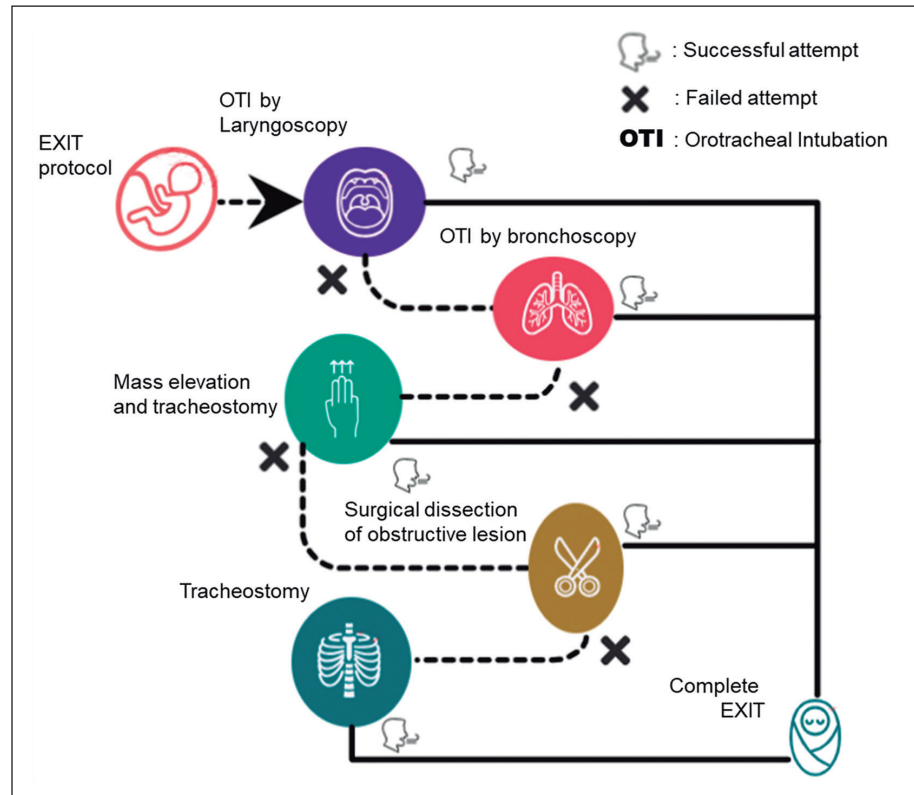


Figure 3. Algorithm to implement the EXIT technique.

study, antenatal and postnatal MRI was performed, allowing the team to make targeted decisions (including the EXIT technique).

The EXIT technique, although safe and with a high success rate, can generate maternal-perinatal complications. The mother requires general anesthesia and prolonged intraoperative periods since uterine relaxation is necessary to maintain placental perfusion and gas exchange, which entails an increased risk of blood volume loss and hysterectomy²⁴. In the fetus, complications are related to the inability to maintain utero-placental gas exchange due to umbilical cord compression, placental abruption, or uterine relaxation^{17,25}. Laje et al reported that 26% of patients with teratoma managed with the technique died⁷ and Macarthur et al reported that mortality related to this technique increases by 36% if the patients have any chromosomal abnormality²⁶. There were no complications in the patients in this study.

Conclusions

The EXIT technique is an option when facing the imminent risk of perinatal asphyxia due to airway compression in the fetus. In order to implement it, a

multidisciplinary team must be trained and have access to technological tools that guarantee the survival of the newborn. In cases where the EXIT technique is indicated, early diagnosis of fetal conditions is essential for timely planning.

Ethical Responsibilities

Human Beings and animals protection: Disclosure the authors state that the procedures were followed according to the Declaration of Helsinki and the World Medical Association regarding human experimentation developed for the medical community.

Data confidentiality: The authors state that they have followed the protocols of their Center and Local regulations on the publication of patient data. exempted from obtaining an informed consent, which is recorded in the respective form

Rights to privacy and informed consent: The authors have obtained the informed consent of the parents (tutors) of the patients and/or subjects referred to in the article. This document is in the possession of the correspondence author.

Conflicts of Interest

Authors declare no conflict of interest regarding the present study.

Financial Disclosure

Authors state that no economic support has been associated with the present study.

References

- Hamid-Sowinska A, Ropacka-Lesiak M, Breborowicz GH. Congenital high airway obstruction syndrome. *Neuro Endocrinol Lett.* 2011;32:623-6.
- Elmasalme F, Giacomantonio M, Clarke KD, Othman E, Matbouli S. Congenital cervical teratoma in neonates. Case report review. *Eur J Pediatr Surg.* 2000;10:252-7.
- Howarth ES, Draper ES, Budd JLS, Konje JC, Clarke M, Kurinczuk JJ. Population-based study of the outcome following the prenatal diagnosis of cystic hygroma. *Prenat Diagn.* 2005;25:286-91.
- Gaffuri M, Torretta S, Iofrida E, et al. Multidisciplinary management of congenital giant head and neck masses: Our experience and review of the literature. *J Pediatr Surg.* 2018;733-9.
- Norris M, Joseph J, Leighton B. Anesthesia for Perinatal Surgery. *Am J Perinatol.* 1989;6:39-40.
- Laje P, Johnson MP, Howell LJ, et al. Ex utero intrapartum treatment in the management of giant cervical teratomas. *J Pediatr Surg.* 2012;47:1208-16.
- Laje P, Peranteau WH, Hedrick HL, et al. Ex utero intrapartum treatment (EXIT) in the management of cervical lymphatic malformation. *J Pediatr Surg.* 2015;50:311-4.
- Laje P, Howell LJ, Johnson MP, Hedrick HL, Flake AW, Adzick NS. Perinatal management of congenital oropharyngeal tumors: The ex utero intrapartum treatment (EXIT) approach. *J Pediatr Surg.* 2013;48:2005-10.
- Mychaliska GB, Bealer JF, Graf JL, Rosen MA, Adzick NS, Harrison MR. Operating on placental support: the ex utero intrapartum treatment procedure. *J Pediatr Surg.* 1997;32:227-30; discussion 230-1.
- Harrison MR, Adzick NS, Flake AW, et al. Correction of congenital diaphragmatic hernia in utero VIII: Response of the hypoplastic lung to tracheal occlusion. *J Pediatr Surg.* 1996;31:1339-48.
- Masahata K, Soh H, Tachibana K, et al. Clinical outcomes of ex utero intrapartum treatment for fetal airway obstruction. *Pediatr Surg Int.* 2019;35:835-43.
- Cruz-Martínez R. MA. Técnica EXIT (Ex Utero Intrapartum Treatment): indicaciones, limitaciones, riesgos y evolución a la técnica de intubación traqueal fetal endoscópica (FETI) The EXIT procedure: Indications, limitations, risks and progress to the. *Rev Mex Ginecol y Obstet.* 2015;83:58-65.
- Taghavi K, Beasley S. The ex utero intrapartum treatment (EXIT) procedure: Application of a new therapeutic paradigm. *J Paediatr Child Health.* 2013;49:E420-7.
- Hedrick MH, Ferro MM, Filly RA, Flake AW, Harrison MR, Scott Adzick N. Congenital high airway obstruction syndrome (CHAOS): A potential for perinatal intervention. *J Pediatr Surg.* 1994;29:271-4.
- Hirose S, Harrison MR. The ex utero intrapartum treatment (EXIT) procedure. *Semin Neonatol.* 2003;8:207-14.
- Hirose S, Farmer DL, Lee H, et al. The Ex Utero Intrapartum Treatment Procedure: Looking Back at the EXIT. *J Pediatr Surg.* 2004;39:375-80.
- Zadra N, Giusti F, Midrio P. Ex utero intrapartum surgery (EXIT): Indications and anaesthetic management. *Best Pract Res Clin Anaesthesiol.* 2004;18:259-71.
- Marwan A, Crombleholme TM. The EXIT procedure: principles, pitfalls, and progress. *Semin Pediatr Surg.* 2006;15:107-15.
- Hirose S, Sydorak RM, Tsao K, et al. Spectrum of intrapartum management strategies for giant fetal cervical teratoma. *J Pediatr Surg.* 2003;38:446-50.
- Chmait RH, Chon AH, Anselmo D, et al. In utero Fetal Intubation for a Large Neck Mass: A Minimally Invasive EXIT Option. *Fetal Diagn Ther.* 2019;45:275-80.
- Prickett K, Javia L. Fetal Evaluation and Airway Management. *Clin Perinatol.* 2018;609-28.
- Ryan G, Somme S, Crombleholme TM. Airway compromise in the fetus and neonate: Prenatal assessment and perinatal management. *Semin Fetal Neonatal Med.* 2016;21:230-9.
- Kathary N, Bulas DI, Newman KD, Schonberg RL. MRI imaging of fetal neck masses with airway compromise: utility in delivery planning. *Pediatr Radiol.* 2001;31:727-31.
- Butwick A, Aleshi P, Yamout I. Obstetric hemorrhage during an exit procedure for severe fetal airway obstruction. *Can J Anesth.* 2009;56:437-42.
- Moldenhauer JS. Ex Utero Intrapartum Therapy. *Semin Pediatr Surg.* 2013;22:44-9.
- MacArthur CJ. Prenatal diagnosis of fetal cervicofacial anomalies. *Curr Opin Otolaryngol Head Neck Surg.* 2012;20:482-90.
- Agarwal A, Rosenkranz E, Yasin S, Swaminathan S. EXIT procedure for fetal mediastinal teratoma with large pericardial effusion: a case report with review of literature. *J Matern Neonatal Med.* 2018;31:1099-103.
- Aubin A, Pondaven S, Bakhos D, Lardy H, Robier A, Lescanne E. Oropharyngeal teratomas in newborns: Management and outcome. *Eur Ann Otorhinolaryngol Head Neck Dis.* 2014;131:271-5.
- Matte GS, Connor KR, Toutenel NA, Gottlieb D, Fynn-Thompson F. A Modified EXIT-to-ECMO with Optional Reservoir Circuit for Use during an EXIT Procedure Requiring Thoracic Surgery. *J Extra Corpor Technol.* 2016;48:35-8.
- Castillo Salinas F, Elorza Fernández D, Gutiérrez Laso A, et al. Recommendations for respiratory support in the newborn (IV). High frequency ventilation, ex-utero intrapartum treatment (EXIT), extracorporeal membrane oxygenation (ECMO). *An Pediatr.* 2017;87:295.e1-295.e7.

