

Review Article

Progression of the Baton Devices in Obturpaedic Cleft Treatment

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Abstract

Neonates born with clefts of hard and soft palate, particularly those diagnosed with Pierre Robin Sequence, often face life-threatening upper airway obstruction, leading to interrupted or continuous apnoea. Immediate intervention is critical to save their lives. This review presents multiple advancements and modifications in most conservative obturpaedic devices that can be swiftly manufactured and fitted without the need for major anaesthesia and surgical interventions. An in-depth description of the developmental progression is provided of various types of Baton devices, highlighting their specific applications through detailed photographs. The review categorises the described two major Obturpaedic divisions into further four subdivisions, demonstrating their positive outcomes in critical neonatal period immediately after birth. Additionally, we observe that these devices have long-term benefits, including improved tongue position, mandibular micrognathic growth and enhanced sucking and feeding abilities. For upper airway obstruction the clinical implication is extremely important for survival of the neonate. Future research is needed, concerning manufacturing material to be used and non-invasive electronic scanning to have these devices directly manufactured in a laboratory.

Keywords: Obturpaedics; Cleft; Hard and Soft Palate Cleft; Neonatal Cleft Child; Cleft With Apnoea; Baton Device; Pre-Epiglottic Appliances; Pierre Robin Sequence; PRS

Abbreviations

C: Cleft; P: Palate; hP: hard Palate; sP: soft Palate; hPsP: hard and soft Palate

Introduction

The field of obturpaedics encompasses highly specialised neonatal and infant treatment intervention, for those mostly born with cleft anomalies [1]. For congenital palatal defects, nonsurgical conservative treatments are crucial to ensure optimal care before the first surgical reconstruction.

Prompt treatment of neonates with possible life-threatening conditions like a Pierre Robin Sequence (PRS) with upper airway obstruction can be both demanding and edifying [2]. These compromised neonates are fighting to breathe and struggle with feeding due to the position of their tongue in the oropharynx, but also due to the typical mandibular micrognathia and microglossia, a part of the additional insufficient congenital oro-facial development. The non-invasive and non-surgical Baton obturator device has progressed into various modifications to accommodate this particular serious circumstance concerning upper airway obstruction. A quick conservative obturpaedic intervention in a Neonatal Intensive Care Unit (NICU), without the need for anaesthesia, can be performed on a neonate immediately after birth for the placement of a first choice Baton device as an emergency intervention. Should a persistent upper airway obstruction be present, a much more demanding intervention with a pre-epiglottic appliances is then indicated. The aim is to render to an orthopaedodontist a clear understanding in sequencing the treatment approach for a neonate with possible upper airway obstruction.

Methods and Modifications

In a neonate born with a cleft of a hard and soft palate, without or with upper airway obstruction, the application of treatment is starting with an uncomplex device (OwE) and is advancing, depending on the severity of airway obstruction and anatomical oro-pharyngeal structures via different types of Baton devices to the most complicated pre-epiglottic appliance.

1. *Obturator-with-Extension (OwE)*

The Obturator-with-Extension (OwE) features a posterior acrylic extension and is the first choice for ensuring breathing and feeding in neonates born with hard and soft palate cleft (hPsP) [1,3]. This modification is rooted in the McNeil obturator designed for cleft patients and can be further modified with a mesh-acrylic extension [4,5]. It is also suitable for neonates diagnosed with PRS without significant upper airway obstruction and feeding difficulties [6,7]. The primary aim of the OwE is to obturate the cleft in a hPsP, creating an artificial border between the oral and nasal cavities (Fig. 1). Oral impression is taken immediately after birth and this artificial border encompasses the cleft of the hard palate and part of the soft palate (Fig. 1) [8]. This allows for normal breathing, feeding and sucking in $\pm 67\%$ of neonates born with hPsP (data is calculated on +5000 well-documented oro-facial cleft anomalies [9,10]). The OwE exerts minimal pressure to reposition the tongue inferiorly and anteriorly, helping to reduce glossoptosis and lessening minor airway obstruction [2].

Neonates born with or without a cleft of the hard and soft palate, where the tongue fits completely or folds into this cleft or is dislodged into the oro-pharyngeal space, especially if a microglossia and a mandibular micrognathia are present, are diagnosed with a glossoptosis and additional apnoea [11]. These neonates experience upper airway problems, interrupted or permanent apnoea and feeding and sucking difficulties. The diagnosed is then established as PRS ($\pm 33\%$ of hPsP) or approximately $\pm 6.5\%$ of all types of cleft anomalies (Fig. 2) [10]. Neonates born with a cleft anomaly in the PRS subdivision are known as Fairbairn Robin Triad (FRT) ($\pm 89\%$). A rare similar anomaly, where no cleft is observed, presents with identical facial features and oro-pharyngeal upper airway problems. This subdivision, characterized by mandibular micrognathia and glossoptosis is known as Siebold-Robin Sequence (SRS) ($\pm 11\%$) [9]. For these additional one third neonates presenting as a FRT or SRS, the OwE may be an insufficient obturpaedic treatment device. As PRS neonates present with glossoptosis they are under constant stress due to intermittent or continuous apnoeal episodes. Once the problem is diagnostically confirmed, the captious neonate requires an immediate different obturpaedic apparatus, such as a Baton-type device [12].

Following successful treatment with a Baton device, eliminating apnoea and feeding problems, the OwE can be reintroduced as a follow-up obturpaedic treatment device until the first surgical reconstruction of the cleft. As previously reported, this reverse exchange from a Baton device to a OwE is only viable if sufficient peri-oral muscles and tongue tensile strength have developed and the apnoea has dissipated [3].

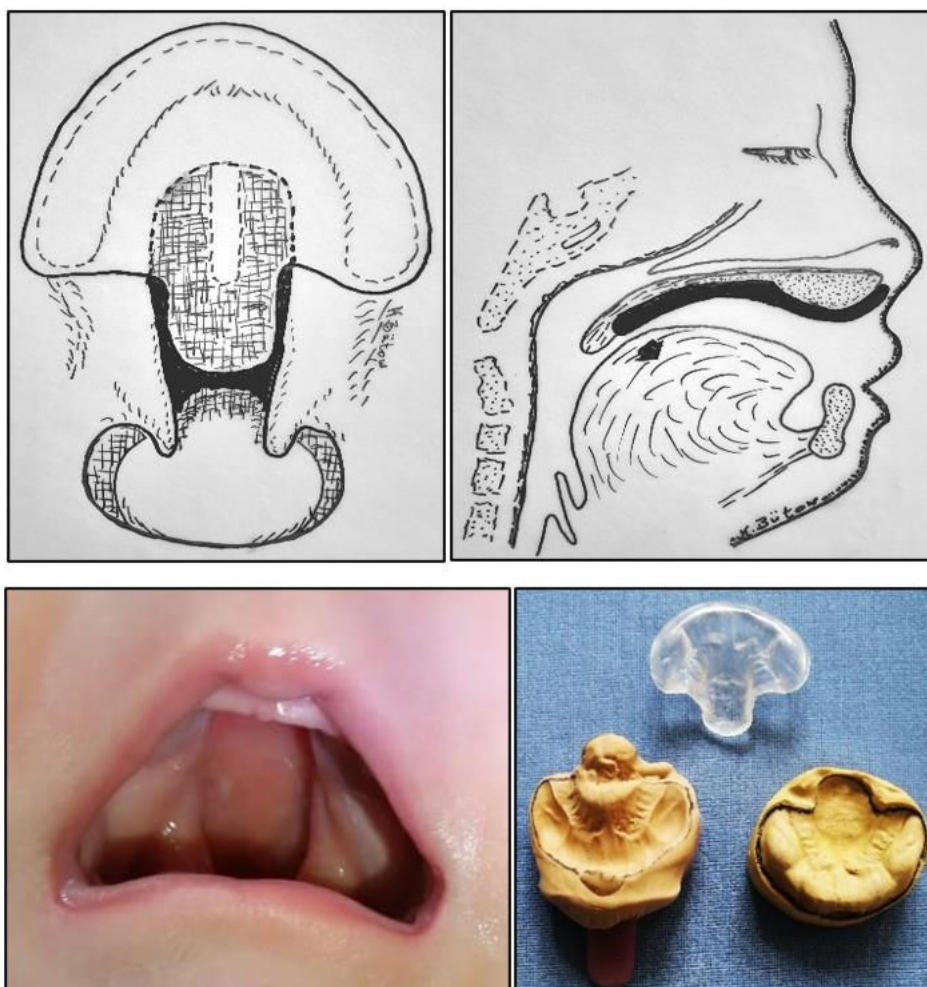


Figure 1: OWE; a: Position intra-orally; b: Position - lateral view; c: Cleft of hard + soft palate; d: OWE acrylic plate with impression and model cast.



Figure 2: Pierre Robin sequence - a: Wide cleft of hard + soft palate; b: Mandibular micrognathia.

2. Baton Device Modifications

Baton with standard acrylic velar extension- Type I

The Baton with standard acrylic velar or dorsal extension is an advanced modified OWE. secured with an anterior pre-formed facial-extension wire-framework to the forehead and an additional size of the velar extension (Fig.3) [3]. This modified obturator is used in neonates presenting with and without a cleft of the hPsP (in $\pm 88\%$) or sP (in $\pm 12\%$), staging with glossoptosis and apnoea. This device is primarily used for neonates born with PRS [2]. The additional retention applied to this facio-oro-

pharyngeal device to the forehead is needed (Fig.4) due to the too-shallow maxillary sulci for retention and to secure the additional tongue force and movement applied against this posterior acrylic extension.

The aim of this type of obturpaedic device is to release the tongue, mostly a microglossia, from the cleft into a more anterior position and to prevent it from occluding against the naso-oro-pharynx wall, thereby overcoming glossoptosis with upper airway obstruction. This is particularly important for PRS and sometimes other types of syndromic cleft and non-cleft patients. Should a decision for a glossopexia, neonatal mandibular distractions or tracheostomy be considered as a surgical alternative, anaesthetics and nursing remains a risk during this pre-reconstruction period. The acrylic velar extension is a standard design but can be slightly modified after manufacturing by shortening and/or narrowing the extension's width. Modification in the superior-inferior dimension is not feasible. Adjustments to this extension are arbitrary after placement in relation to the posterior surface of the tongue.

The clinical oral impression and manufacturing of this oro-facial Baton device is intrigue and sensitive. Further special measurements must be taken from the vermilion border to an area slightly higher than the eyebrows. These oral impressions and facial measurements are submitted to an experienced dental technician for manufacturing. The Baton-type-I device is fitted at the maxillo-palatal surface, obturating the palatal cleft and securing stability. The facial extension resting on the forehead should be secured with special taping and adhesive materials. The metal-wire facial framework is integrated into the Baton palatal acrylic part, preventing displacement by tongue pressure and movement, thus reducing the obstruction in the naso-oro-pharynx. The acrylic extension applies some posterior-inferior pressure on the tongue for a more anterior position, keeping it partially displaced from the cleft region and temporarily securing it in a more natural oral environment. Consequently, this palatal part of the plate fosters a more natural medio-lateral palatal narrowing growth of the cleft defect. This growth during the crucial presurgical or obturpaedic period mitigates the need for extensive surgical repair of the hard and soft palate cleft. The Baton-type-I device may indirectly stimulate mandibular growth for a more anterior mandibular development [3].

This device is placed without anaesthetic as a conservative treatment and can be fitted in a NICU. It is the first choice to advance the tongue into a more anteriorly position, creating a larger breathing canal in the naso-oro-pharynx. This conservative treatment avoids surgical intervention to secure normal breathing.

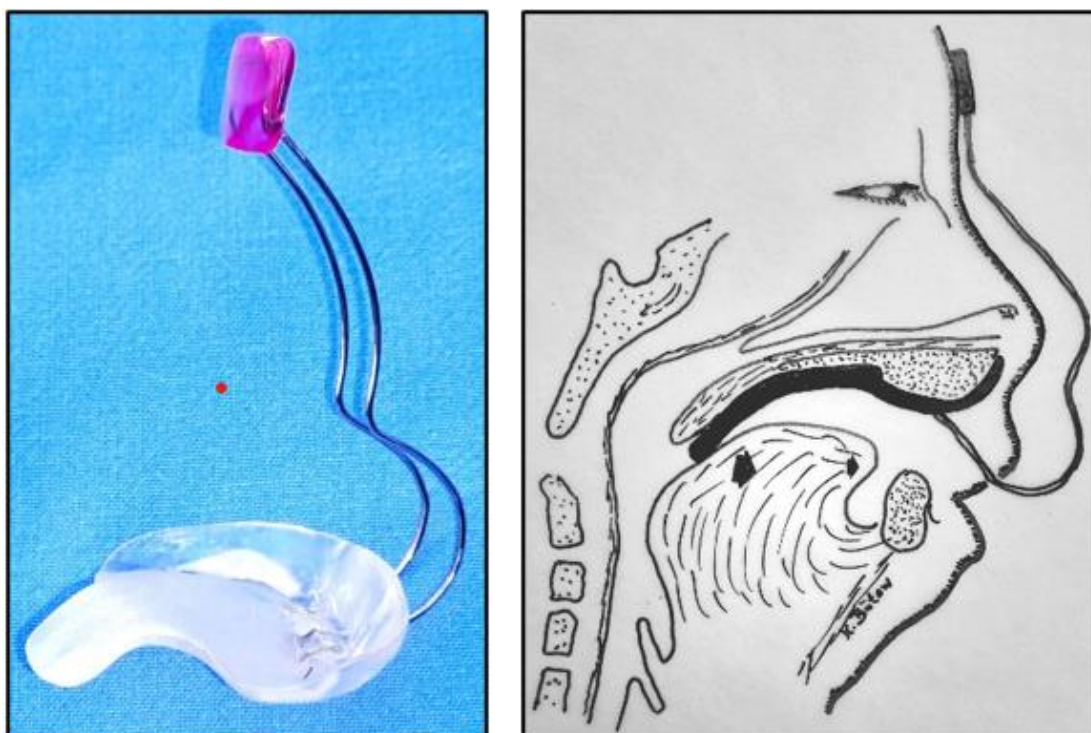


Figure 3: Baton-type I device: a: With palatal acrylic extension and facial footplate; b: Lateral view - placement.



Figure 4: Baton-Type-I device: a: Anterior facial view; b + c: Lateral facial view.

Baton with modified velar with wire extension and small acrylic foot plate-Type II

This Baton features a bendable modified velar extension with two wires strongly and securely attached to a small acrylic foot plate (Fig. 5) [3]. This extension, located in the oro-pharynx against the posterior surface of the tongue, allows various adjustments in all dimensions, particularly the superior-inferior and anterior-posterior dimensions. Immediate repositioning of the footplate after the placing of the device can accommodate a preferential position at the posterior part of the tongue.

Impressions and measurements are taken similarly to the Baton-type-I device. The main benefit of this particular obturpaedic device is the flexibility of the small acrylic footplate, which can be adjusted multiple times to determine and secure the optimal position at the posterior area of the tongue, creating a larger breathing canal in the naso-oro-pharynx and achieving normal breathing without apnoea interruptions. This dorsal extension is small enough to avoid airflow obstruction yet large enough to prevent pressure ulcers from developing at the surface connecting to the tongue. The extension, is classically not extended by 2 cm and easily inserted through the oral cavity into the neonate's oro-pharyngeal region. Strong wires secure the oro-pharyngeal extension in the palatal acrylic plate, accommodating pressure at the acrylic foot plate and additional facial forehead extension (Fig. 6). The design of the palatal part for obturating the cleft in the hard palate and partially the soft palate is compatible with the Baton-type-I device.

Owing to the reduced diameter of this oro-pharyngeal extended foot plate system, the Baton-type-II device can be rapidly and efficiently positioned in the NICU. This procedure can typically be completed within the same day or the following day after the intra-oral impressions and measurements has been taken. Moreover, this approach eliminates the need for prototypes, thereby avoiding additional delays.

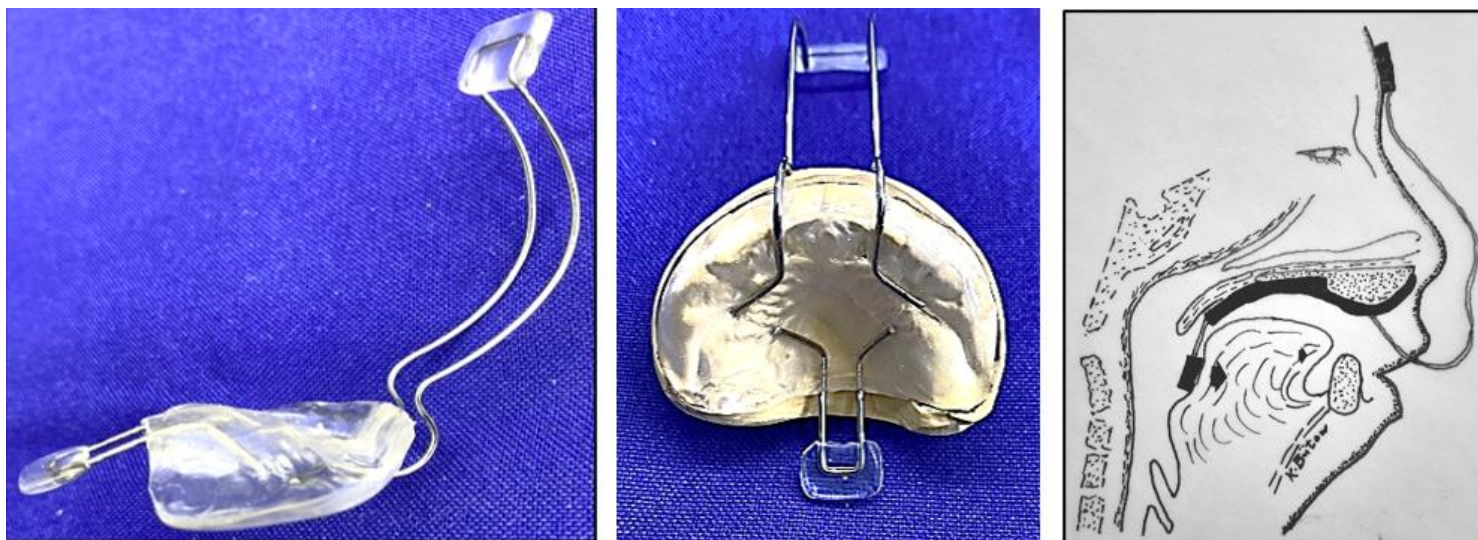


Figure 5: Baton-type-II device: a+b: With wire acrylic oro-pahangeal and facial foot-plates; c: Lateral view - placement.



Figure 6: Baton-type-II device - *in-situ*: a: Anterior facial view; b: Feeding with device.

Baton device with modified facial extension-Type III

The third modification to the Baton device involves specific adjustments to the extra-oro-facial extension wires to accommodate oxygen supply and nasogastric feeding tubes [3]. This adaption is essential for neonates requiring prolonged care in the NICU. This modification is applicable to both Baton-type-I or type-II devices. The dorsal foot plate modification for the Type II device is more sophisticated, with the external facial modification suitably applied to the Baton-type-II. The intra-oral impression procedure remains consistent with that used for the OWE and Baton-types-I and II appliances. The external supero-inferior measurements are similar, with the exception that the external facial wire extension necessitates an excentric bend to avoid interference with nasogastric and/or naso-tracheal tubes (Fig. 7,8).

The precise measurements and curvature regulation of the arch of the facial extension in the Baton-type-III device are critical to accommodate the excentric bend required for oxygen supply and nasogastric feeding tubing without exerting pressure on or from wires at the facial extension framework. It is essential to prevent interference between the facial extension wire and the naso-tracheal and naso-gastric tubes to avoid pressure necrosis around the neonatal nostril. This facial wire extension should

conform around the upper lip similarly to the Baton- types-I and II devices but necessitates at least one or both wires to bend laterally at the prolabium for its excentric facial position. These two facial wires are joined in a facial acrylic foot plate, secured in the same manner as described for the Baton-types-I and II devices.

The application of Baton-type- III device is similar to that of the previously mentioned devices, as it does not require general anaesthesia or the manufacturing of prototype device(s) and can be fitted in the NICU.

All Baton devices necessitate adjustments approximately every four weeks due to the continuous growth of the oro-facial structures. A similar second device is typically indicated after three months and before the first primary surgical reconstruction. When the peri-orbicular muscles are sufficiently developed, these device transitions to an OwE by removing the facial extension.

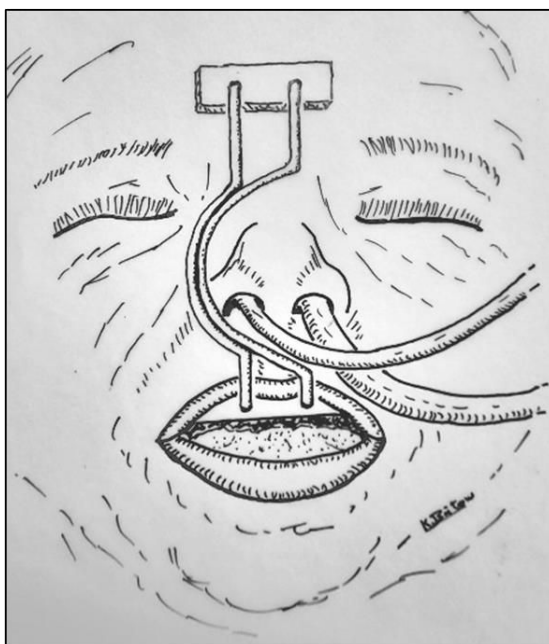


Figure 7: Baton-type III device - with the special manufactured external extension.



Figure 8: Baton-type III device - *in-situ* adjacent to the endotracheal and feeding tubes [3].

3. Pre-Epiglottic Appliance

The pre-epiglottic appliances, also referred to as Pre-Epiglottic Baton Plate (PEBP), Tübinger palatal plate or Margit-Bacher device, represents an advanced form of baton appliances featuring a progressive inferior expansion at the posterior or dorsal part of the tongue extending into the hypopharynx (Fig. 9) [13-15]. The anterior repositioning of the tongue root ensures airway patency by 'stabilising' the pharyngeal wall anteriorly and widening the hypopharynx through the anterior displacement of the posterior area of the tongue.

Endoscopically control crucial to secure the correct superior-inferior length and diameter of the 3-4 cm long pharyngeal extension. Final insertion is always performed with the aid of nasopharyngoscopy, as precise seating is pivotal for airway improvement. Consequently, the manufacturing of one or more prototypes is vital due to the inflexibility of the acrylic pharyngeal component. This fixed extension, composed of a non-bendable acrylic part, allows only minimal adjustments, similar to the Baton-type-I device. However, like the Baton-type-II, a strong wire can be inserted between the obturator plate and the vertical acrylic baton [3,16].

This appliance demands a significantly greater manufacturing and clinical input due to the necessity of multiple prototypes. Adjustments sessions, which are endoscopically controlled, results in prolonged hospital stays and often require a theatre setting. The extra-oral wires are positioned obliquely from the baseplate to the cheek areas and are secured to the forehead with over-cross tapes [14]. These wires can be replaced by a reinforced type as used in Baton-types- I to III devices [3].

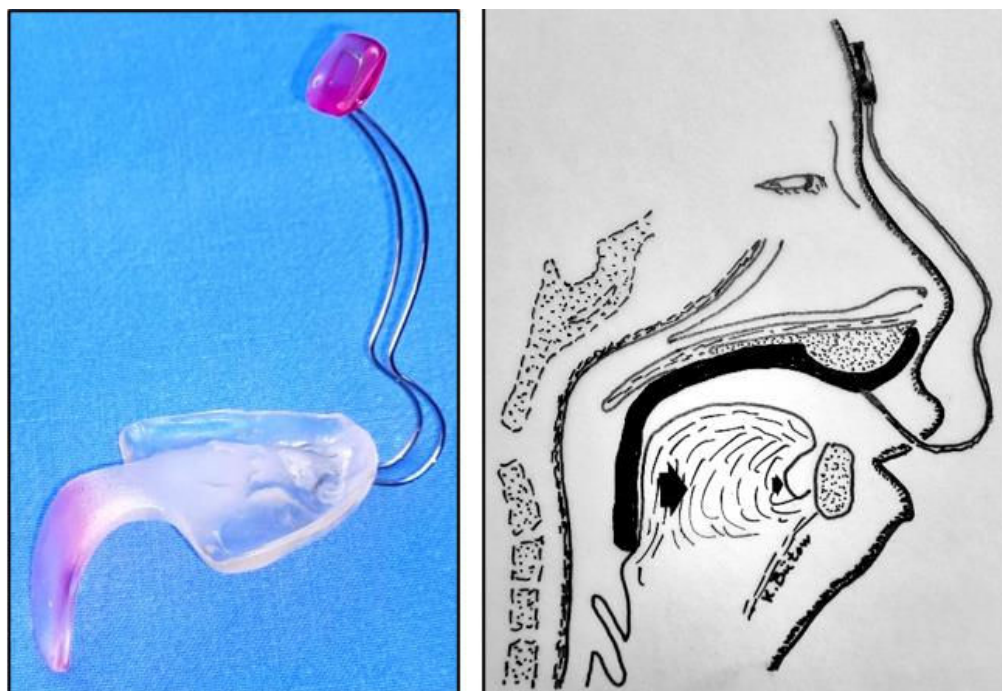


Figure 9: Lateral view of Pre-epiglottic appliance; a: Baseplate with facial and hypopharyngeal extension; b: Extension pressure in oro-hypopharynx, lateral view - placement.

Result and Discussion

Two of the seven important treatment modalities for neonates and infants with oro-facial anomalies were partially described under Obturpaedic treatments [3]. This clinical review highlights the progression, along with additional subdivisions and their specific indications.

For two-thirds of patients born with cleft of the hard and soft palate, the OWE device serves as an effective intervention by obturating the hard palate cleft and partially obturating the cleft in the soft palate due to the extension [3]. The slight pressure exerted on the tongue by the extension encourages a more natural tongue position, positively influencing sucking and feeding. In one-third of patients born with a hard and soft cleft, typically presenting with a wide U-shaped defect, an additional serious problem is encountered: glossoptosis with upper airway obstruction, leading to apnoea and potential long-term negative

developmental effects [17]. Accompanying features often include micrognathia of the mandible and microglossia. Most of these neonates are diagnosed with PRS with a cleft palate, sub-categorised as a FRT. However, this condition can also be observed in the sub-category of SRS, presenting identical facial and pharyngeal features without a cleft anomaly [2]. Rarely, undiagnosed or unknown syndromes [18], with or without laryngomalacia, might present with similar problems as observed in SRS. For this specific one-third group of neonates/infants, the Baton devices, with their three different modifications and the pre-epiglottic appliance, are essential treatment options and can be classified as life-saving devices [19]. It is crucial that the breathing-exhausted neonate does not become fatigued during attempts to facilitate better breathing. A prompt positive outcome with a Baton device *in-situ* can mean the difference between life and death.

The Baton-types-I, II and III devices function marginally different due to the facial-frontal modified extension and the velar-pharyngeal or dorsal extension in the oro-pharynx. The most effective types are the Baton-type-II and the Baton-type III devices. The type-III is especially suited for neonates who need to be nursed in the NICU with naso-tracheal and naso-gastric tubes *in-situ*. The time required for taking oral impression, facial measurements and manufacturing of a Baton device is between one to two days [7]. The placement of the device is conservatively done by an orthopaedodontist with the support of a paediatric community-nurse, without any other additional special interventions.

The design of the pre-epiglottic appliance for a neonate is considerably more demanding, requiring a team approach to apply endoscopic evaluation and control placement of the extended pharyngeal part of an extended baton in the hypopharynx [13,14]. Fitting and placing the prototype necessitates hospital theatre time for endoscopic control, as the airway must be secured in the supine position during this procedure, with Paediatric Anaesthesiologist and theatre personnel on standby, especially if the neonate was previously receiving Continuously Positive Air Pressure (CPAP) treatment [20]. The position of this pharyngeal baton and its effect on the root of the tongue in its new anterior hypopharyngeal position need careful evaluation. Manufacturing this device intercedes one or more prototypes. The pre-epiglottic appliances are indicated when Baton-type-II device cannot eliminate apnoea or when additional laryngomalacia is diagnosed [16,19]. According to studies, the pre-epiglottic appliances allow immediate, simultaneous correction of the tongue and mandibular anterior position, increasing physiological airway while ensuring tongue mobility. An overall positive development in breathing, swallowing and phonation improvement is recorded with long-term normal neurocognitive outcomes observed [14,16].

In treating critical neonates, the principle “first do no harm” should be the highest priority in efforts to pursue an open airway for this perplexed infant group diagnosed with PRS or an unknown syndrome [14]. Successful fitting with a Baton device adheres to this principal avoiding immediate surgical interventions such as glossoptosis/tongue-lip-adhesion, subperiosteal releasing of the floor of the mouth, bilateral mandibular osteotomies with distractions, and/or tracheostomy [21].

In many cases of PRS, co-existing medically compromised may preclude tolerance for general anaesthesia. Therefore, it merits exploring immediate, non-invasive, conservative, yet potentially lifesaving treatment modalities to secure breathing and possibly improve sucking and feeding.

Conclusion

The significance of orthopaedodontic treatment for the neonates and infants are essential with its very specific benefits as a non-surgical care and it underscores the implication for neonatal care as well as its positive long-term outcome. The types of Obturpaedic Treatment applications are enormously important for the immediate lifesaving treatment where upper airway obstruction is diagnosed in a neonate. It improves the survival rates, developmental outcomes and quality of life for neonates. The obturator-with-extension (OwE) device role is an initial intervention to stabilise breathing and feeding. The role of the different Baton and pre-epiglottic appliance highlights the more specific application where the situation is more serious as airway management and its positive anterior mandibular development with tongue positioning. In succession the different designs of Baton devices are introduced via their different development with its meaningful application. The Baton-Type-II in particular may be used during home care, where the Baton-Type-III is recommended in the NICU where naso-tracheal and feeding tubes are necessary. All of these three designs are vital in avoiding, where possible, various types of surgical modalities as a primary intervention for the upper airway obstruction. There is an inherent flexibility as demanded by the severity and adaptability from the suitability in use at home and in the NICU. As the last outcome for a non-surgical treatment application is the use of the pre-

epiglottic appliances with acknowledgement of the complexity in its manufacturing, placement and adjustment in a theatre environment. The successful application of one of these designs is securing an immediate increase in pharyngeal volume of the naso-oro-hypo-pharynx for breathing, sucking, swallowing and feeding in these severely affected neonates.

The benefits of these five different devices further enhances in the post-reconstruction orthopaedodontic period specific treatments and long-term health outcomes. This subdivision of Obturpaedic treatment augments eventual specifically the post-reconstruction phase in future Orthopaedodontic treatment in patients with PRS and cleft of the hPsP for their optimal long-term outcome of the wider well-researched and established protocol, described as 'Ultimate Cleft Treatment'.

Conflict of Interests

The authors have no conflict of interest to declare.

Language Evaluation

AC Wolmarans.

Confirmation of Patient's or Parent's Permission

Patient/parent's permission obtained.

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