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Balloon catheter dilatation in Otorhinolaryngology

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Abstract

Over the years, various tubal surgical techniques have been proposed eg: laser tuboplasty and bypass surgeries but most of which characterized by invasiveness and possible damage to tubal mucosa. These treatments show insufficient results. The introduction of microsurgical and endoscopic techniques as balloon catheter dilatation is a promising option for chronic tube dysfunction. Transferring this technology in otorhinolaryngology for the dilatation of the obstructed tubes such as paranasal sinuses ostium, Eustachian tube, nasolacrimal duct, salivary gland ducts and others paves the way for further treatment options, particularly for chronic tube malfunction. The objective of this article is to review and highlight the effectiveness of using balloons for dilatation of tubal and ostial obstructions in otorhinolaryngology.

Keywords: balloon, catheter, dilatation, duct stenosis.

Introduction

Obstructive tube dysfunction often involves a chronic functional defect in which the regular aeration and ventilation as well as the self-cleaning capability are limited. The consequences of this malfunction include the development of chronic inflammatory changes resulting in subsequent complications. Historically many different treatments have been tried to solve tubal obstruction either medical or surgical eg: laser tuboplasty and bypass surgeries but most of which characterized by invasiveness and possible damage to tubal mucosa. These treatments show insufficient results. The introduction of microsurgical and endoscopic techniques as balloon catheter dilatation is a promising option for chronic tube dysfunction. Balloon tuboplasty is a new procedure in which insertion of small balloon to dilate or expand the tubal opening and drainage pathways to restore drainage and promote healing [1].

Materials and Methods

The data in this review article were collected from different papers which published in different medical journal by those authors who approved this procedure. For the performance of the balloon catheter, traditional functional endoscopic surgery materials are required, as well as specific tools. Endoscopes sets of 0, 30, 45 or 70 degrees may be used. In addition, a set of guide-catheters, flexible guide-threads, flexible balloon-catheters, washing

catheters and pump for the balloon insufflation with manometer are necessary. The BCD procedure was offered to patients after subjective, physical and otorhinolaryngological examinations, all of the procedures followed were in accordance with institutional ethics committee approval.

Results

There are a promising results regard to balloon catheter dilatation published over last year's suggested the success of this technique for examples:

The results of a prospective multicenter analysis published by Bolger et al in (2005)[2], they found that initial evidence of the safety and effectiveness of balloon catheter sinusotomy has been encouraging. Results published by Weiss et al in (2008)[3], found impressive symptoms improvement in patients' symptoms underwent balloon catheter sinusotomy in ESS with 2 years follow up, also Wittkopf et al in (2008)[4] reported using dilating balloon catheters for the surgical treatment of 31 immunocompromised and critically ill patients with acute rhinosinusitis. These immunocompromised patients had associated conditions such as thrombocytopenia, neutropenia, and anemia. They concluded that these patients may have been treated as successfully with standard through cutting instrumentation; the balloon catheter offered a safe and effective surgical option with potentially less risk of bleeding related complications. Another result published by Asker et al., in (2015)[5], suggests that endoscopic frontal sinusotomy assisted with dilation via a 10F Foley catheter is a safe and cost effective option in management of chronic frontal sinusitis and may be a valuable adjunct for rhinologists working in the developing world.

Discussion

The treatment principle of balloon dilatation in otorhinolaryngology is similar to that of balloon dilatation in vascular stenosis [6]. It is hypothesized that this procedure will reduce mucosal trauma as compared to typical endoscopic surgery techniques, thus reducing the formation of scar tissue and restenosis at obstructed ostia [1].

Transferring this technology in otorhinolaryngology for the dilatation of the obstructed tubes such as paranasal sinuses ostium, Eustachian tube, nasolacrimal duct, salivary gland ducts and others paves the way for further treatment options, particularly for chronic tube malfunction [6].

Applications of balloon catheter dilatation in otorhinolaryngology:

Balloon sinuplasty is a new technique in performing endoscopic sinus surgery that further reduces mucosal damage and advances us toward our ultimate goal of improving function with maximal mucosal preservation without cutting bone or removing tissue using balloon catheter system. BCS can be used alone as a sole intervention for one or more sinuses, or in combination with more conventional ESS [7]. The indications for balloon sinuplasty are not different from those for performing endoscopic sinus surgery. BCS is proposed to treat patients with chronic sinusitis who have exhausted less aggressive treatment options [8]. There are currently two manufacturers of FDA approved devices for balloon catheter dilation of the frontal, maxillary and sphenoid sinuses. Both devices come in one package. The Acclarent system has a guide catheter for the respective sinuses (maxillary, frontal, and sphenoid), Subsequent devices developed by Acclarent have also been approved. These include the Relieva Spin Sinus dilation System, approved in August 2011, and the Relieva Seeker Balloon Sinuplasty System, approved in November 2012. In June 2008, the device, Fin ESSTM Sinus Treatment (Entellus Medical, Inc, Maple Grove, MN) was approved. The Entellus system has a probe that can be fashioned according to which sinus is targeted [9]. The surgeon performing BCS of multiple sinuses should consider working from a posterior to anterior approach in order to minimize operative bleeding into the endoscopic surgical field. If necessary, sphenoid disease should be treated first, followed by maxillary, then frontal BCS.

If other procedures, such as septoplasty and/or inferior turbinate reduction, are indicated, they are usually performed afterward to minimize any bleeding or tissue edema that may interfere with placement of the dilating balloon catheter [10]. Balloon sinuplasty appears to be a safe, effective, minimally invasive treatment option to relieve paranasal sinus ostial obstruction, low recurrence rates and doesn't limit future treatment option if a patient has progressive disease. A potential problem of BCS is that the instruments needed to perform the surgery are not reusable, and the cost of the disposable instrumentation may increase the total cost of the procedure [9]. Several studies have shown the success of the procedure in adults and proved that the procedure is safe and feasible in children who had CRS and failed medical therapy. While use of any surgical instrument involves some risk [10].

Surgical management of chronic frontal sinusitis can be challenging due to complex and variable anatomy of the frontal recess, difficult transnasal visualization and manipulation without angled instruments and endoscopes, as well as the high tendency of the frontal sinus for scarring and restenosis [11]. Balloon catheter dilatation has been promoted as a less invasive alternative to traditional instruments used in ESS, resulting in reduced pain and quicker recovery [12]. A Foley catheter can be used during ESS in chronic rhinosinusitis when there is edema of the frontal recess, with exclusion of tumors, granuloma, and excessive scarring of the frontal recess, which is better removed by through-cutting instruments. It can be used after clearance of frontal recess cells and identification of the frontal sinus ostium to compress the edematous mucosa and remnants of bony lamella with consequent widening of the frontal recess and drainage of retained secretions in a way similar to what others have described as the "hybrid technique. Balloon catheter doesn't replace conventional instruments in most cases of endoscopic frontal sinus surgery and its effective adjunct in selected patients undergoing endoscopic frontal sinus surgery. It preserves mucosa with little crusting after the procedure with potentially better postoperative healing and less scarring [13].

Balloon catheter dacryoplasty is minimally invasive lacrimal procedures that utilizes specially designed balloons targeted at targeted at different points in the lacrimal system for a wide range of indications as an alternative to dacryocystorhinostomy in the management of nasolacrimal duct obstruction either complete obstructions or partial obstructions in children and adults [14]. In lacrimal surgery, balloons were first used by Becker and Berry in 1989. Around the same time Munk et al. (1990) reported balloon catheter dilatation for adults with epiphora using an angioplasty catheter under fluoroscopic guidance. Advantages of balloon catheter dacryoplasty (over the external or endoscopic DCR) include: reduced operative trauma, less bleeding, faster and less time consuming, no need for powered endoscopic instruments, less postoperative morbidity, early rehabilitation and high success rates [15].

Many different treatments have been tried to solve ETD. Among these are systemic antihistamines and corticosteroids, intranasal corticosteroids and decongestants, noninvasive autoinflation manoeuvres, ET catheterisation, bougie dilatation, drilling of the bone, laser tuboplasty and other invasive treatments. These treatments have not shown enough evidence of success [16]. BET involves the use of special balloons to dilate the cartilaginous part of the Eustachian tube through its opening in the nasopharynx under direct visualization with a nasal telescope. Once placement of the balloon is confirmed, it is inflated with saline for 2 minutes. The saline is then removed to deflate the balloon, and the catheter device is removed. Because the Eustachian tube is close to the internal carotid artery, there is concern about injury to this critical structure by inflating the balloon in the Eustachian tube. To reduce this risk, most surgeons will obtain a preoperative imaging study to confirm the anatomy of this region. In addition, specific devices have been designed to reduce the risk of ICA injury [17]. This method has proven to be feasible, safe and rapid. Balloon tuboplasty appears to give a better chance for graft healing and restoration of middle ear integrity [18].

Balloon sialoplasty is a recent nonsurgical method of relieving obstruction caused by salivary duct stenosis [19]. Strictures can be dilated with balloon catheters under endoscopic vision. The indications for balloon catheter sialoplasty are all salivary gland swellings of unclear origin including, swelling as associated with calculi, strictures, inflammation or tumors and other processes that may cause obstruction of the duct with failure of conservative measures such as gland massage or as alternative to surgical methods which are associated with significant morbidity, such as wound infection and hematoma [20]. Balloon sialoplasty obviates the need for general anesthesia and has no reported complications. Balloon catheter sialoplasty preserves the gland also it is a simple, safe, and clinically effective method of relieving obstructive symptoms of salivary glands duct stenosis [21].

Bronchoscopic balloon dilatation has been considered a simple, rapid and safe method to restore airway caliber in cases of laryngotracheal stenosis. BBD has been used alone or in combination with other modalities such as laser resection, cryotherapy and electrocautery [22]. BBD has been established as both safe and efficient in the treatment of subglottic stenosis in adults and children, and reduces the need for open laryngeal surgery by 70–80% [23]. The major advantages of BBD are lower morbidity and mortality than surgery, stent placement, or bougienage. BBD has thus become an accepted treatment for benign tracheobronchial stenosis. BBD is useful not only for increasing the tracheobronchial diameter of the stenotic segment but also for improving respiratory function and symptoms [24].

Endoscopic balloon dilatation in treatment of esophageal atresia is a new non-surgical treatment modality gives a new hope in the children where the traditional methods may be very traumatic. Dilatation with a balloon is better than with a bougie because the expansile force is applied uniformly and radially at the site of the stricture, whereas a bougie exerts a shearing axial force that results in a greater degree of trauma and thereby increases the risk of perforation [25].

Various studies have reported that this technique is especially effective for treating congenital rather than acquired esophageal strictures in children [26].

A balloon catheter dilatation for the dilation of choanal atresia or stenosis is a new method alternative to traditional surgical approaches which are invasive and associated with large wounds and tissue defects, necessitating intensive postoperative care [27]. Using balloon sinuplasty system, a balloon catheter is placed in the nasal cavity under control with a 0° degree rigid endoscope while the child is under general anaesthesia after decongestion of the nasal mucosa with cottonoids soaked in decongestant nose drops. Under simultaneous transoral endoscopy of the nasopharynx with a rigid 90° angled endoscope; a light source catheter is placed in the small choanal opening. The light source catheter is subsequently advanced into the nasopharynx. The sinuplasty balloon catheter is then gently rotated into the residual lumen, with the light source catheter as guide wire. The balloon is inflated with normal saline solution until a pressure of 8 atm is reached. The residual lumen is thus enlarged to a diameter of 7 mm without any signs of hemorrhage or swelling. There are no uniform recommendations about the ideal pressure or the duration of the actual dilatation. Brown und Bolger used pressures between 10-16 atmospheres (mean maximum pressure 13 atm) for about 5 seconds, with an inflation/deflation interval of 10 seconds each. The balloon remains inflated for 5 minutes and is then deflated. An increase of pressure of 2 atmospheres during each step is sufficient to build up adequate pressure in the balloon. The advantage of this method is minimal trauma to surrounding tissues as dilatation occurs without any classical surgical intervention, like incisions, tissue removal, suturing or coagulation [28].

Conclusion

Balloon catheter dilatation is an endoscopic tool and may be used with other medical therapies and/or surgical techniques. It does not limit future treatment options if a patient has progressive disease. BCD has been proved to be safe,

effective and less invasive in terms of distortion of the original anatomy and mucosal disruption, thereby minimizing potential for synechiae formation and ostial stenosis and decreasing the need for postoperative debridements, when compared to traditional techniques which characterized by the invasiveness of these methods and possible damage to the nasotubal mucosa. Last but not least, balloon catheter can be used in the management of epistaxis, patients with frontal bone fracture, stabilization of the isolated zygomatic arch fracture and in patients with trigeminal neuralgia. The initial evidence of the safety and effectiveness of BCD has been encouraging. Further researches are needed establish the place of this type of surgery in management of tubal obstruction and to compare balloon dilation and other surgical techniques.

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