Review Article

Balloon Dacryoplasty: Indications, Techniques and Outcomes

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Abstract: Balloon dacryoplasty is a term used for a set of minimally invasive lacrimal procedures that utilize specially designed balloons, targeted at different points in the lacrimal system for a wide range of indications. Balloons were first used by Becker and Berry in 1989. This article would review the details of various balloons, instruments needed, indications in pediatric and adult populations, preoperative preparations, operative standards and procedures, postoperative managements and outcomes.

Key Words : Baloon Dacryoplasty, Minimally invasive, Lacrimal procedure

Introduction

Balloon dacryoplasty is a term used for a set of minimally invasive lacrimal procedures that utilize specially designed balloons, targeted at different points in the lacrimal system for a wide range of indications. Balloons were first used by Becker and Berry in 1989.[1] Around the same time Munk et al reported balloon catheter dilatation for adults with epiphora using an angioplasty catheter under fluoroscopic guidance.[2] There are ongoing efforts worldwide to look for an alternative to dacryocysto-rhinostomy (DCR) in the management of nasolacrimal duct congenital nasolacrimal duct obstructions (CNLDO) and adult partial nasolacrimal duct obstructions.

This gave impetus to the exploration of balloons in form of 9 mm balloon DCR for primary and revision cases, 5 mm balloon dilatation for internal ostium stenosis and 2 or 3 mm balloon dilatation for alternative to dacryocystorhinostomy (DCR).

This article would review the details of various balloons, instruments needed, indications in pediatric and adult populations, preoperative preparations, operative standards and procedures, postoperative managements and outcomes.

Balloons and Instruments

A good nasal endoscopic set up is ideal for a balloon dacryoplasty. A typical Balloon dilatation set (Atrion Corporation, Allen, Texas, USA) (Fig 1) consists of the following:

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a) 2 mm, 3mm, 5mm or 9mm balloon catheters
b) Inflation device
c) Lacrimal probes
d) Punctum dilator
e) Dandy's nerve hook
f) Intubation set with retrieval device

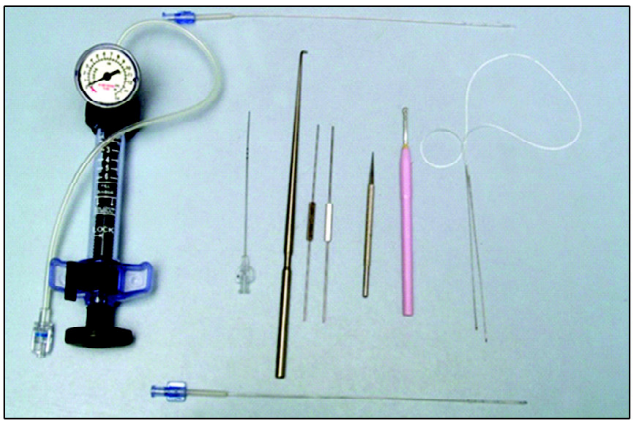

Fig 1: A complete balloon dacryoplasty set. Note the presence of the 2 mm catheter.

Balloon catheters are specially designed with an inflatable balloon at one end of the catheter and hub with luer-lock mechanism at the other which engages the inflation device. 2 mm balloons catheters are named so since they have an outer diameter of 2 mms during an inflated stage (Fig 1). The length of this balloon is 13 mms. Similarly 3mm balloon has an outer diameter of 3mms but the length is 15 mms. The 5 mm (Fig 2) and 9mm (Fig 3) balloons have outer diameters of 5 mm and 9 mm respectively but their length is 8 mms. 9 mm balloon catheter is much sturdier and is angulated at 120 degrees focused within the balloon segment. Two important markings on the 2mm

and 3 mm catheters is the 10 mm and 15 mm black marks to serve as a guide when the catheters are within the nasolacrimal ducts (Fig 1).

The inflation device has a manometer which displays the pressure reading in atmospheres (Fig 1). Proximal end of the manometer has a tube with a luer-lock adaptor for attachment to the catheters and the distal end has a locking device and a knob. When the locking device is to the left, it indicates an unlocked stage, whereas if it is to right, it indicates a locked stage. The knob when rotated clockwise with the manometer in locked stage, steadily increases the pressure within the device and inflates the balloon whereas its anti-clockwise rotation reduces the pressure and thus deflates the balloon. Preoperative and Intraoperative nasal endoscopic examination is essential for these procedures.

Fig 2: A 5 mm balloon catheter.

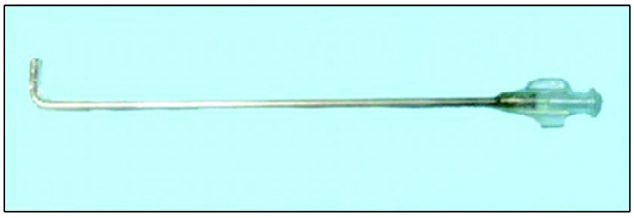

Fig 3: A 9 mm balloon catheter

Balloon Dacryoplasty in Children

Syringing and Probing has been a standard of care for congenital nasolacrimal duct obstructions (CNLDO). Although it is a good procedure with high success rate, the same is not true for older children.[3-4] Probing is less effective in older children because of complex blocks or diffuse narrowing of the nasolacrimal duct.[5-6] Silicone intubations are generally carried out in older children or those who fail probing but the drawbacks of these procedures in children including stent prolapse, second sitting for removal of tubes and keeping them in-situ for 2-3 months need to be taken into account.[7]

Balloon dilatation came into vogue because it achieves true dilatations of narrowed segments, easier to perform than primary silicone intubation with good success rates. A 2 mm balloon is used for patients less than 30 months of age and 3 mm for children more than 30 months of age. The indications of balloon dacryoplasty for congenital nasolacrimal duct obstructions[1,6,8,9] are:

a) Failed Probing

b) Failed intubation

c) Older children (>12 months of age)

d) Down's syndrome or any syndromic association with CNLDO

Surgical technique

Preoperative preparation includes decongestion of the inferior meatus with 0.05% Oxymetazoline. 2 drops can be placed half an hour before the procedure or alternatively a cottonoid soaked with the drug can be placed in inferior meatus for 5 minutes before the procedure. Following dilatation of the puncta, a probing is performed as a standard procedure and the probe is inspected in the inferior meatus to confirm that all the blocks are overcome. An I-probe (Quest Medical Inc, Allen, Texas, USA) can be used which is similar to a bowman's probe with a small eyelet near the tip to wash off the debris following probing and also to reflect on the free flow following probing. Inferior turbinate medialization may occasionally be needed along with probing if it appears to be impacted to the lateral wall.

The sleeve of the balloon is removed, it is then lubricated with either a viscoelastic or a 1% CMC (carboxymethycellulose) drops and gently placed into the lacrimal system just like the procedure of probing and introduced further into the nasolacrimal duct till the 15 mm mark is adjoining the puncta or the balloon exits just beyond the valve of Hasner as seen with nasal endoscopy (Fig 4). In the meantime the inflation device filled with saline or fluorescent stained saline should be ready in the locked position. The air should be removed from the device after saline filling. The luer-lock hub of the inflation device is connected to the catheter and the knob is slowly rotated in the clockwise direction by the assistant while the surgeon can be visualizing the dilatation of the balloon via the endoscope.

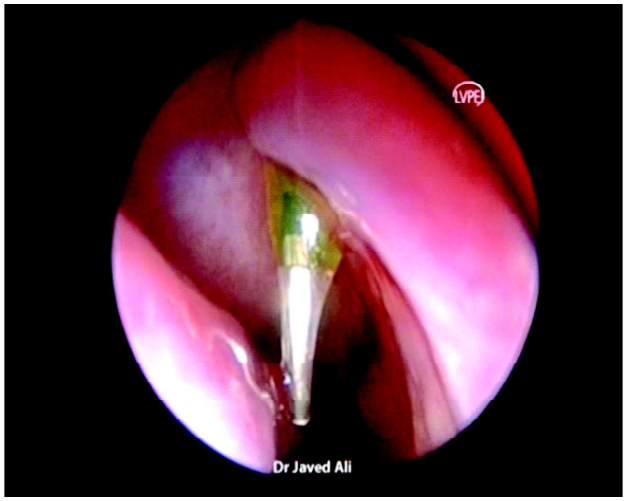

Fig 4 : Endoscopic view of the naso- lacrimal duct dilation using a 3 mm balloon catheter.

The balloons are inflated to 8 atmospheres of pressure for duration of 90 seconds. The inflated balloon should be under constant monitoring in the nose (Fig 4). The knob of the inflation device is then rotated in an anti-clockwise manner to deflate the balloon. Once deflated, without disturbing the catheters position, it is re-inflated to 8 atmospheres for 60 seconds. The balloon is again deflated and pulled back till the 10 mm mark adjoins the punctum or the tip of the balloon is barely visible proximal to valve of Hasner. The two cycles of inflation and deflation are carried out again in this position. The catheter and the inflation device are then disconnected followed by gentle withdrawal of the catheter from the lacrimal system. The lacrimal passages are then irrigated with either saline or fluorescein stained saline. The fluid should flow easily and in copious amounts indicating success of the procedure. The saline from the inflation device is then emptied after unlocking the device.

The author practices the use of intravenous dexamethasone 4 mg during surgery. Post-operatively, topical steroid-antibiotic (Tobramycin-Fluormethalone) combinations are given in tapering doses over 2 weeks. Patients are examined at 6 weeks and 3 months and the outcome measures that are looked for is tear meniscus height, relief in symptoms, and occasional dye disappearance test. Numerous publications have classified the outcomes as excellent if the child has complete resolution of epiphora with normal tear drainage, good if the child has minimal residual symptoms with minimally delayed dye disappearance test, fair if there are moderate residual symptoms or delayed dye clearance and poor if there is no improvement.[1-11]

Outcomes

Balloon dacryoplasty for congenital nasolacrimal duct obstruction is a very effective treatment modality for specific indications as mentioned already. The success rates range from 76% to 83% in various large case series.[8-11] Tien DR[8] following his study of 39 lacrimal systems observed that balloon catheter dilatation is simple and atraumatic and should be considered as an alternative to silicone intubation in patients who undergo probing. Tao S et al[9] studied 73 lacrimal systems of CNLDO undergoing balloon catheter dilatation with patients whose mean age was 35.6 months. 39 (53%) of these were failed probing or post silicone intubation. The overall success rate was 76.7% but it was very interesting to note that children undergoing secondary dilatation following failed previous procedures did not show a statistically significant difference (P = 0.8165) in outcomes when compared to the primary group. Therefore it was concluded that balloon catheter dilatation appears to be successful especially for older children who fail probing or silicone intubation. Leuder et al[10] studied the outcomes of balloon dacryoplasty in 76 children above the age of 18 years. Though the procedure did not appear to benefit simple obstructions more than probing, it however was beneficial in 82% (n=28) of the patients who had stenosis of the distal nasolacrimal duct. Leuder et al[11] further studied the efficacy of balloon catheter dilatation in 32 children with persistant congenital nasolacrimal duct obstructions (CNLDO) following previous failed attempts at recanalization. Outcomes were found to be excellent and good in 28% and 47% of the patients respectively. Yuskel et al[12] studied the efficacy of balloon dilatation in older children with a mean age of 43.9 months with a mean follow up of more than 25 months and reported success rates of close to 90%. The concept of balloon dacryoplasty for older children especially post probing is steadily gaining rapid ground as an alternative to silicone intubation and dacryocystorhinostomy. The authors of the present study are conducting a study in older children who failed probing earlier. A combination of balloon dilatation and silicone intubation is performed and the initial results appear to be promising, however long term results would ascertain its efficacy.

Balloon Dacryoplasty in Adults

There has been a renewed interest in using minimally invasive approaches for partial and complete nasolacrimal

duct obstructions in adults. This led to increased attention to the use of balloon-assisted lacrimal surgeries in adults. We will discuss this under 2 headings, Partial NLD obstructions and complete NLD obstructions

Partial Nasolacrimal Duct Obstructions

Incomplete NLDO's are usually managed with a dacryocystorhinostomy. With the advent of balloons several studies have looked at the efficacy of using 3 mm balloon dilatation in such cases. The procedure is similar to what has been described above for pediatric dacryoplasty except that probing needs to be much more meticulous to overcome the multiple blocks or diffuse narrowing of the nasolacrimal ducts. This is followed by a primary intubation under endoscopic guidance. The authors usually use Crawford tubes or I-Stents (Quest Medical Inc, Allen, Texas, USA) and retain them for 12 weeks before removal.

Perry JD et al[13] reported a success rate of 73% after treatment with balloon dilatation and intubation for partial obstructions in adults. Kuchar A et al[14] reported an overall success of 90% in improvement of symptoms in adults and 56% experiencing complete resolution of epiphora. The authors in their unpublished study of 21 partially obstructed nasolacrimal ducts of 12 patients have shown an anatomical patency of 71% and functional success of 62%, 6 months after removal of stents. The later parts of this study have shown an additional benefit of doing balloon dacryoplasty under dacryo-endoscopic guidance.

Complete Nasolacrimal Duct Obstructions - EBA DCR

For complete obstruction, Endoscopic Balloon assisted Dacryocystorhinostomy (EBA-DCR) using the 5 mm or more commonly the 9mm is an alternative to standard external or endonasal DCR's. One difference that needs to be kept in mind here is that unlike the 5 mm balloon which is used via the trans-canalicular route, the 9 mm can only be used transnasally (Figs 2 and 3). The authors use 5 mm balloon catheter only for revision DCR's and the 9 mm balloon catheter for both primary and revision DCR's. There is very scanty literature on the use of 3 mm balloons targeting the completely obstructed nasolacrimal ducts in adults.[14-16] Song et al[15] and Janssen et al[16] found initial failure rates ranging from 41-44%, however others like Kuchar et al[14] found a failure rate of 10.7% at the end of one year. The clinical use of 3 mm balloons targeting the completely obstructed nasolacrimal ducts is very limited and generally not followed, but such patients are being increasingly managed by the 9mm balloon assisted primary endoscopic DCR.

9 mm primary endoscopic balloon DCR Primary endoscopic DCR using the 9 mm balloon catheter (Fig 2) is a good alternative to an external or endoscopic DCR. It was introduced and popularized by Silbert DI.[17] The advantages of this procedure include

a) Reduced operative trauma
b) Less bleeding
c) Faster and less time consuming
d) No need for powered endoscopic instruments
e) Less post-operative morbidity
f) Early rehabilitation
h) High success rates

Surgical Technique

Good case selection is vital for the success of any surgery and so is true for 9 mm endoscopic balloon DCR. Suspicion of any lacrimal sac tumor, severe deviated nasal septum and canalicular obstruction are contraindications, the former being an absolute and latter two being relative. Anesthesia can be general or monitored anesthesia care with sedation. Once the patient is under anesthesia, lidocaine 2% with adrenaline combination is injected in nasal sub mucosal plane, 2-3 cc, anterior and inferior to the axilla of the middle turbinate. The nose is then packed with cottonoids soaked in 0.25% Oxymetazoline, placed under the middle turbinate and in front of its insertion with the help of bayonet forceps, preferably under endoscopic guidance.

Once the patient is draped, the nasal pack is removed and the puncta are gently dilated progressively to allow number 3 or 4 reinforced bowman's probe to be passed into the lacrimal sac. The probe is directed towards the infero-posterior part of the lacrimal fossa, since it is very thin and can be easily overcome. Once the bone is overcome, the position of the middle turbinate is assessed and if needed a mild medialization of the middle turbinate is carried out. The probe is then passed inferiorly and superiorly in a honeycomb pattern initially followed by opening of the lacrimal sac in a 'filleting open' motion. A blakesly forceps is then introduced into this small opening and pulled back into the nose with its mouth wide opened. Bits of tissues around now can be gently removed. The 9

mm balloon catheter is now connected to the inflation device and introduced into the nose with the balloon end going in first. Under the guidance of the bowman's probe, the catheter is introduced into the newly made ostium and inflated to 8 atmospheres for 90 seconds. It is then pulled into the nose backwards with the balloon still inflated (Fig 5). The balloon is deflated, introduced into the ostium again and reinflated for 60 seconds and again pulled back in the inflated state. This makes the ostium very big and fragments of bone and mucosa are then removed. Once the ostium is of adequate size, intubation is carried out with Crawford tube or the specially designed large diameter Stent tubes. The nose is then packed using cellulose sponges.

Soon following the surgery a single intravenous dose of 8 mg dexamethasone is administered. Postoperatively the patient is placed on systemic antibiotics, topical antibiotic-steroid combinations, nasal decongestant and saline nasal douching. The patient is reviewed at 1 day, 1 week, and 3 months. The tubes are retained for 12 weeks. The outcome measures that are looked for is tear meniscus height, relief in symptoms, and occasionally dye disappearance test. Routine syringing is not practiced by the authors unless patient complains of epiphora.

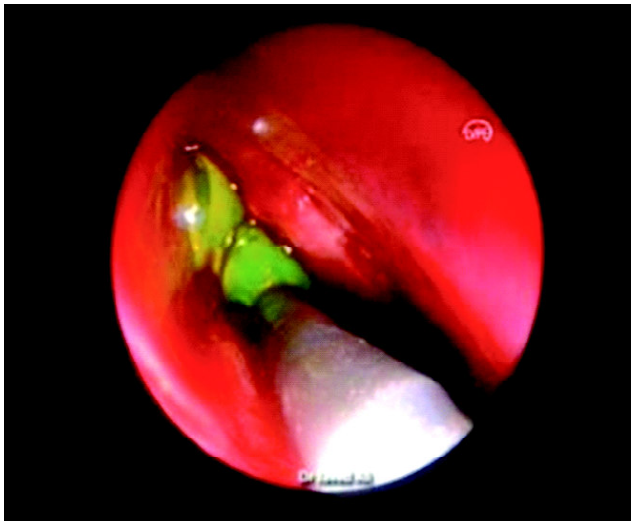

Fig 5: Endoscopic view of a 9 mm primary EBA DCR.

Outcomes

The results of primary endoscopic 9 mm balloon DCR's in long term are appearing to be quite encouraging. Silbert DI[17] in a large case series of 97 patients reported success rates of 92%. Among the 8 cases which failed in this series, 3 underwent repeat surgery, one of them with 5 mm balloon and were successful.[17] Longer follow up with still larger number of patients will ascertain its efficacy in long run.

Balloon Assisted Revision DCR

Revising a failed DCR is a challenging job. For primary external and endoscopic DCR, the failure rate has been reported to be 5-10% or less and 10-20% or less, respectively.[18-19] The most common cause of a DCR failure is occlusion of the rhinostomy site by soft tissue or cicatricial closure of the Ostium. The stenotic or occluded DCR fistula is amenable to balloon dilatation. It is of advantage since the occlusion is primarily a soft tissue and the bony window is usually adequate. The authors use both 5 mm and 9 mm balloon catheters for their failed external or endonasal cases.

The 5 mm catheters (Fig 2) are usually used for very early failures where there is usually a stenotic fistula. A bowman's probe is passed to identify the area in front of the common canaliculus and to clear any soft tissue. The 5 mm balloon catheter is then inserted through the upper canaliculus and under endoscopic guidance, the DCR fistula is enlarged with the standard inflation (Fig 6) and deflation cycles are discussed already. Following dilatation of fistula, any soft tissues in the vicinity are gently removed, mitomycin c 0.04% is applied, followed by Crawford intubation. The 9 mm balloon catheter is also used in the same fashion as already described for primary DCR. Though long term studies are not available, the initial results in the unpublished author series look promising. What needs to be stressed is identification of all the etiological factors contributing to the DCR failure and addressing them adequately yields satisfying results.

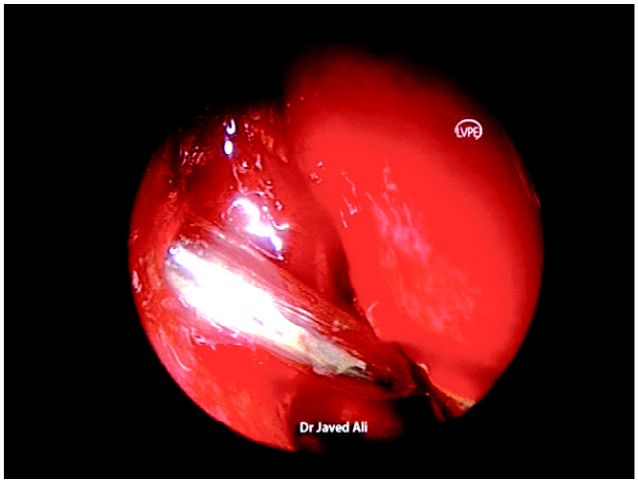

Fig 6 : Endoscopic view of the DCR ostium enlargement using a 5 mm balloon.

Conclusions

Balloon dacryoplasty and Balloon-assisted primary and revision DCR's are speedily gaining grounds in minimally invasive lacrimal surgeries with increasing indications for their use. These techniques are essential in the armamentarium of a dacryologist. Careful patient selection and skillful nasal endoscopy are important factors for successful outcomes.

A good clinical armamentorium along with constant innovative habits helps facing challenges thrown by lacrimal disorders thrilling and profitable.

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Financial Support : Declared None
Conflict of Interest : Declared None