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Monocanalicular Versus Bicanalicular Silicone Intubation for Nasolacrimal Duct Stenosis in Adults

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Purpose: To compare the success rate of monocanalicular versus bicanalicular silicone intubation of incomplete nasolacrimal duct obstruction (nasolacrimal duct stenosis) in adults.

Methods: In a retrospective, nonrandomized comparative case series, 48 eyes of 44 adult patients with nasolacrimal duct stenosis underwent endoscopic probing and either bicanalicular (BCI; n = 22 eyes) or monocanalicular (MCI; n = 26 eyes) nasolacrimal duct intubation under general anesthesia. "Complete success" was defined as complete disappearance of the symptoms, "partial success" as improvement with some residual symptoms, and "failure" as absence of improvement or worsening of symptoms at last follow-up. The last follow-up examination included diagnostic probing and irrigation if there was not complete success.

Results: Patient ages ranged from 31 to 90 years (mean, 69; SD, 11.5). Forty-five tubes were removed 6 to 17 weeks (mean, 9.1; SD, 3) after surgery. Premature tube dislocation and removal occurred in one eye with BCI and in two eyes with MCI. Follow-up ranged from 6 to 52 months (mean, 14.9; SD, 8.4). The complete success rate was nearly the same in eyes with MCI (16/26, 61.53%) and BCI (13/22, 59.09%). Partial success (MCI: 8/26, 30.76%; BCI: 1/22, 4.54%) and failure (MCI: 2/26, 7.69%; BCI: 8/22, 36.36%) were, however, significantly different ($p = 0.010$). Complications included 3 slit puncta with BCI and 4 temporary superficial punctuate keratopathy after MCI.

Conclusions: MCI had virtually the same complete success rate as BCI, a higher partial success rate than BCI, and a lower failure rate than BCI in treatment of nasolacrimal duct stenosis in adults.

Nasolacrimal intubation with silicone tubing without performing a dacryocystorhinostomy for nasolacrimal duct stenosis was first described by Keith in 1968.[1] Since then, the technique has been modified to facilitate the passage and retrieval of the tubes. Silicone intubation of the nasolacrimal drainage system has been performed in patients with canalicular and/or nasolacrimal duct (NLD) obstruction that is either complete or incomplete.[2,3] Complete and incomplete nasolacrimal duct obstruction can be differentiated with an irrigation test of the lacrimal drainage system, as we described. Complete nasolacrimal duct obstruction (NLDO) is inferred if saline regurgitates totally through the other punctum. Forceful irrigation resulting in the passage of fluid in the nostril associated with partial reflux through the punctum is defined as nasolacrimal duct stenosis (NLDS).

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Reported success rates were higher in patients with canalicular obstruction than in those with NLDO.[2,3]

Bicanalicular intubation involves passage of the tube through the inferior and superior puncta and through the nasolacrimal drainage system into the nose, leaving a loop of tubing extending from the inferior to superior puncta. Various techniques have been described to retrieve and secure the free ends of the tubing within the nose.[4–7]

Monocanalicular intubation of the nasolacrimal drainage system with a Monoka tube (FCI, Paris, France) has been popularized since 1992.[8–10] The monocanalicular technique requires a single pass through the system, with no need to secure the distal end of the tube within the nasal passage and no time spent adjusting the tension on the proximal end of the tubing at the inner canthus. Kaufman and Guay-Bhatia[8] stated that the main advantage of monocanalicular versus bicanalicular intubation of the nasolacrimal drainage system is the technical ease of insertion and removal of the tube.

The aim of this study was to compare success rates of monocanalicular versus bicanalicular silicone intubation of incomplete nasolacrimal duct obstruction (NLDS) in adults. To the best of our knowledge, this is the first study comparing monocanalicular versus bicanalicular intubation of NLDS in adults.

METHODS

In a retrospective, comparative analysis of interventional cases performed between 1999 and 2003, 48 eyes from 44 consecutive adult patients with epiphora and NLDS underwent endoscopic probing and silicone intubation of the NLD by an oculoplastic surgeon and oculoplastic fellow at Norwich University Hospital. All patients' notes were reviewed, and those with less than 6 months' follow-up were recalled to the clinic for further assessment. Patients with previous eyelid and/or lacrimal surgery, complete punctal, canalicular, and/or NLDO, eyelid malposition, nasal or lacrimal drainage system tumors, and less than 6 months' follow-up were excluded.

The diagnosis of NLDS was based on a history of tearing, dye disappearance test results, and diagnostic probing and irrigation tests. The dye disappearance test was performed with a drop of 2% fluorescein sodium (Chauvin Pharmaceuticals Ltd., Brentwood, United Kingdom) instilled in the conjunctival fornix and assessed after 5 minutes to see how much of the dye remained in the tear meniscus. A diagnostic probing of the upper lacrimal drainage system and irrigation of the nasolacrimal duct was then performed.[11] Patients with reflux of fluid through the opposite canaliculus and simultaneous irrigation to the nose and throat on irrigation test, with or without common canalicular membranous stenosis,[11] were included. Severity of the stenosis was not recorded. Different surgical options were explained, and informed consent was obtained.

There were 26 (54.2%) monocanalicular intubations (MCI) with self-threading Monoka tubes (Fayet-Bernard Ritleng type, FCI) and 22 (45.8%) bicanalicular intubations (BCI) with Ritleng tubes (FCI) performed under general anesthesia.

The nose was prepared by placing a cotton-tipped applicator soaked with adrenaline 1/1000 in the inferior meatus 10 to 15 minutes before the procedure. The inferior turbinate was either lightly pushed medially or fractured with a Freer elevator to make insertion of the endoscope in the inferior meatus easier. Our probing technique has been described previously and was the same in this study.[12] Nasal endoscopy was performed to find the end of the Bowman probe coming out of the inferior nasal meatus. A small bulge on the lateral wall of the inferior meatus was seen in some cases in which the vertically oriented probe lay submucosally on the lateral wall of the inferior nasal meatus. In such a case, an incision of the mucous membrane was made and the end of the probe was released in the inferior nasal meatus. The Bowman probe was then removed and replaced with a Ritleng probe, which was likewise observed with an endoscope to ensure correct passage in the inferior meatus. Endoscopically assisted intubation, either MCI or BCI, was then performed. Intubation was not performed in patients with false route of the probe in the middle meatus or inferior concha.

In the bicanalicular technique, a Ritleng tube was used, which consists of a silicone tube with attached Prolene threads at either end. One of these Prolene ends was then inserted into the probe and retrieved from the inferior meatus. The silicone tube was then pulled into the nose. This process was repeated from the upper canaliculus to retrieve the second end of the tube. Eight to 10 knots were made in the ends of the tube in the nose, with adjustment of traction on the punctal side of the tube.

In the monocanalicular technique, a Monoka tube (3-mm flange) was inserted through the Ritleng probe in a similar way to the BCI-MT but just from the lower canaliculus. We had experienced easier insertion of the Monoka tube from the lower punctum without increased keratopathy. The nasal end of the Monoka tube was pulled into the nose, and the head (flange) was fixed in the inferior punctal ampulla with the forceps. The distal

end of the tube within the nose was cut and left to dangle freely.

Patients were instructed to use 0.5% chloramphenicol (Cusi Ltd., United Kingdom) and 0.1% dexamethasone (Maxidex, Alcon, Hertforshire, United Kingdom) eye drops, 4 times per day, for 1 week. Follow-up was arranged in 6 to 8 weeks for removal of the tube.

Removal of the Monoka tube involved pulling it out with a pair of forceps from its flange end at the lacrimal punctum under topical anesthesia (0.4% benoxinate). In removing the bicanalicular tube, the nasal end of the tube was endoscopically found and grasped before cutting the loop between the two lacrimal puncta. The tube was then pulled out through the nasal cavity. Patients were again reviewed 6 months after tube removal.

"Complete success" was defined as complete disappearance of the symptoms. "Partial success" included all patients who had improvement but some residual symptoms. "Failure" was defined as absence of improvement or worsening of symptoms. The last follow-up examination included diagnostic probing and irrigation if complete success was not achieved. Results of the diagnostic probing and irrigation were recorded, and appropriate management was offered to the patients at the last follow-up. Data were studied using the software SPSS MS Window Release 9.0, Chicago, IL. The chi-square/Fisher exact test was used for statistical analysis.

RESULTS

Forty-eight eyes from 44 patients were studied. Twenty-five patients were 31 to 70 years of age and 23 were 71 to 90 years of age (range, 31 to 90 years; mean, 69.02; SD, 11.58,). Twenty-eight patients (63.63%) were female. The right eye was involved in 15 of 44 (34.09%), the left eye in 25 of 44 (56.81%), and both eyes in 4 of 44 (9.09%) patients. Duration of symptoms ranged from 4 to 60 months (mean, 23.02; SD, 13.87). There were 6 eyes (6/22, 27.27%) with associated common canalicular membranous stenosis in the BCI group and 2 eyes (2/26, 7.69%) in the MCI group on diagnostic probing (Fisher exact test, $p = 0.11$). A BCI intubation was performed in 22 of 48 (45.83%) and MCI in 26 of 48 (54.16%) eyes.

Slight nasal bleeding was seen in some cases, with both MCI and BCI, which was easily controlled. One BCI and one MCI displaced and were removed, and one MCI fell out within 2 weeks after surgery. Four patients (4/22, 18.18%) with MCI reported temporary ocular surface discomfort associated with nasal corneal superficial punctuate keratopathy, which was managed with topical lubricants for a few days. Three eyes were noted to have slit puncta at the time of tube removal in the BCI group. No other complications were seen.

Tubes were removed between 6 and 17 weeks (mean, 9.11; SD, 3.04) after surgery. There were 6 tubes removed between 12 and 17 weeks after surgery due to patient unavailability. Follow-up ranged from 6 to 52 months (mean, 14.97; SD, 8.44).

Statistically insignificant effects of factors associated with MCI and BCI groups are shown in Table 1.

At last follow-up, there was complete resolution of symptoms in 29 of 48 (60.41%), partial success in 9 of 48 (18.75%), and failure in 10 of 48 (20.83%) eyes. Although the complete success rate was nearly the same in eyes with MCI (16/26, 61.53%) and BCI (13/22, 59.09%), partial success and failure rates were significantly different (Table 2).

There was no statistically significant effect of sex, age, unilateral or bilateral involvement, duration of preoperative symptoms, presence or absence of associated common canalicular membranous stenosis, time of tube removal, and follow-up period on the success rate ($0.10 < p < 0.87$).

TABLE 1. *Results of statistically insignificant factors associated with 26 monocanalicular and 22 bicanalicular nasolacrimal duct intubations for nasolacrimal duct stenosis in adults*

	MCI	BCI	p*
Sex			
Male	11/25 (44%)	5/19 (26.31%)	0.34
Female	14/25 (56%)	14/19 (73.68%)	
Age (y)			
0–70	11/26 (42.30%)	14/22 (63.63%)	0.16
71–90	15/26 (57.69%)	8/22 (36.36%)	
Laterality			
Right	11/26 (42.30%)	8/22 (36.36%)	0.77
Left	15/26 (57.69%)	14/22 (63.63%)	
Duration of symptoms (mo)			
0–12	7/26 (26.92%)	9/22 (40.90%)	0.61
13–24	1/26 (3.84%)	2/22 (9.09%)	
>24	13/26 (50%)	10/22 (45.45%)	
Missing data	5/26 (19.23%)	1/22 (4.54%)	
Diagnostic probing			
Normal	24/26 (92.30%)	16/22 (72.72%)	0.11
CCS	2/26 (7.69%)	6/22 (27.27%)	
Time of tube removal (wk)			
6–12	19/26 (73.07%)	20/22 (90.90%)	0.33
>12	5/26 (19.23%)	1/22 (4.54%)	
Displaced	2/26 (7.69%)	1/22 (4.54%)	
Follow-up time (mo)			
6–12	10/26 (38.46%)	11/22 (50%)	0.57
7–24	13/26 (50%)	10/22 (45.45%)	
>24	3/26 (11.53%)	1/22 (4.54%)	

MCI, monocanalicular intubation; BCI, bicanalicular intubation; CCS, common canalicular stenosis.

*Chi-square/Fisher exact test.

TABLE 2. *Success rate of monocanalicular and bicanalicular intubation of nasolacrimal duct for 48 eyes with nasolacrimal duct stenosis in adults*

	BCI	MCI
Complete success	13/22 (59.09%)	16/26 (61.53%)
Partial success	1/22 (4.54%)	8/26 (30.76%)
Failure	8/22 (36.36%)	2/26 (7.69%)

BCI, Bicanalicular intubation; MCI, monocanalicular intubation. Chi-square value; 9.08; *df*, 2; $p = 0.01$; 95% CI, 0.008 to 0.012.

Diagnostic probing and irrigation was performed on 19 eyes reporting partial success or failure (Table 3) after NLD intubation. A successful dacryocystorhinostomy procedure was performed on 9 eyes with failure and 1 eye with partial success. Further surgical intervention was declined in the other patients.

DISCUSSION

A basic surgical principle is to reach the most successful result with the least possible trauma. In the modern surgical era, achieving successful results in a cost-effective fashion is also important. The silicone tubing acts as a temporary stent maintaining patency while the tissues around the stent heal.[13] Hurwitz[14] stated that the concept of passing tubes through the pathology underlying the NLDS does not alleviate or circumvent the underlying process. He advised that a long follow-up period is crucial to be sure that success is achieved.[14] Therefore, patients with at least 6 months' follow-up were included in this study.

The monocanalicular Monoka tube was originally designed by Fayet and Bernard.[15] It has been modified by Ruban et al.[16] in 1995 and Ritleng[17] in 1998. Although there are some published reports comparing MCI and BCI of the nasolacrimal system in children,[8,18,19] to the best of our knowledge, this is the first study comparing MCI and BCI for NLDS in adults.

TABLE 3. *Results of diagnostic probing and irrigation in 19 eyes with partial success or failure of 48 nasolacrimal duct intubations for nasolacrimal duct stenosis in adults*

	NLDS	NLDO	CCS	NLDS + CCS	Normal
BCI with PS (n = 1)	1/1 (100%)	...	...	...	...
BCI with F (n = 8)	4/8 (50%)	4/8 (50%)	...	...	...
MCI with PS (n = 8)	3/8 (40%)	1/8 (20%)	1/8 (10%)	1/8 (10%)	2/10 (20%)
MCI with F (n = 2)	1/2 (50%)	1/2 (50%)	...	...	...

NLDS, Nasolacrimal duct stenosis; NLDO, nasolacrimal duct obstruction; CCS, common canalicular stenosis; BCI, bicanalicular silicone intubation; MCI, monocanalicular silicone intubation; PS, partial success; F, failure.

Ariturk et al.[13] found a 53% success of NLDS silicone intubation after a mean follow-up of 4.7 months. Angrist and Dortzbach[20] reported a success rate of 73.9% in patients with NLDS.

We could not find any previous studies of the success of Monoka tube MCI on NLDS or NLDO in adults. MCI has, however, been used for intubation of 48 congenitally obstructed nasolacrimal ducts, and an overall success (complete and partial) of 93% was achieved when the tube was in place for 4 to 6 months.[8] This rate of success was diminished to 62% when early Monoka tube removal was required due to complications.[8] A good success rate was, however, reported with early bicanalicular tube removal at 6 weeks.[21]

In our series, complete success was achieved in 59.09% eyes with BCI and 61.53% eyes with MCI (Table 2). Although these success rates are lower than those of dacryocystorhinostomy, there are some advantages to the use of silicone intubation. It follows a normal anatomic pathway rather than a nonphysiologic bypass of the NLD and permits a shorter and bloodless operation. Associated common canalicular stenosis, duration of preoperative symptoms, and age were not significantly different to account for the difference in the partial success and failure rate in two groups. Last follow-up irrigation and diagnostic probing showed more significant pathology in the failed or partially improved BCI than MCI group (Table 3). The number of cases in each group was, however, too small to perform statistical analysis. This could be a result of more severe stenosis before surgery or increased injury to the nasolacrimal drainage system secondary to the double insertion of the probes used in the BCI group. We did not assess the severity of NLDS before surgery and as a result cannot determine if either factor accounts for the decreased success in this group. We would therefore recommend preoperative assessment of the severity of the obstruction by means of patients' symptoms and also by diagnostic tests.

Several authors have reported slitting of the punctum and canaliculi after bicanalicular silicone intubation of the nasolacrimal drainage system.[21–23] Other complications of bicanalicular silicone tube intubation include punctal slitting, tube displacement, infection, corneal abrasion, tube breakage, and retained tube after severance of the canthal loop.[22–26] Additionally, removal of bicanalicular tubing has been problematic without recruiting a nasal endoscope in some cases. In this series,

there were 3 (11.5%) slit puncta and 1 premature extrusion of the tube after BCI. We had no problems removing the tube, as it was performed endoscopically.

Although some of these problems are avoidable with monocanalicular tubing, there are still some complications arising with the MCI. Kaufman and Guay-Bhatia[8] reported 2 corneal abrasions, 21 (43.7%) premature extrusions of the MCI (17 removed by the patients and 4 by the authors), and 1 corneal ulcer in 48 eyes with congenital NLDO (mean age, 31.8 months). Premature tube extrusion was less in other studies (5.7% to 18.6%).[15,16,19] It has been argued that excessive punctal dilation, meatal ring rupture, and slit punctum should be considered as predisposing factors of premature tube extrusion.[27] Moreover, although the flange on the punctal plug of a MCI gives an advantage of easy tube removal, the tube is also easily pulled out by children, resulting in premature tube extrusion. Giving a good explanation to the patients and/or their guardians to prevent eye manipulation can decrease this chance. Patients participating in our series were adults and given instructions to prevent premature tube extrusion. There were, however, two premature tube extrusions (7.6%) in our series of 26 MCI (mean age, 74.1 years).

Corneal ulceration and abrasion were found in 3 cases (6.2%) of MCI with a 4-mm flange.[8] Glatt[28] reported 8 cases (20%) with superficial punctuate keratopathy of 40 external dacryocystorhinostomy surgeries using an MCI (4-mm flange); two of these needed tube removal. This author did a small comparative study and found no advantage of the 3-mm flange over the 4-mm flange in avoiding tube-related keratopathy. This complication may be decreased with insertion of the tube from the upper punctum and not inserting in a posteriorly displaced punctum.[27] Tube-related keratopathy can be attributed to the shape of the flange rather than its size.[27,28] We recruited a 3-mm flange MCT-MT introduced from the lower punctum (R2C15+) in our series and found that 4 (15.3%) cases with temporary corneal superficial punctuate keratopathy responded well to lubricating drops. We agree with prior studies[8] that MCI is technically easier and faster to perform than BCI.

Fayet et al.[18] found that the success rate did not seem to correlate with the duration of intubation after 1 month but the complication rate did. Migliori and Putterman[21] reported a 100% success rate of bicanalicular NLD intubation for congenital nasolacrimal duct obstruction with tube removal at 6 weeks without complications. Frueh[29] mentioned that most complications from silicone tubing occur in the interval 2 to 4 months after placement of the tubing. In our series, we planned tube removal at 6 to 8 weeks after surgery, but, due to patient unavailability, there were 6 tubes removed between 12 and 17 weeks after surgery. We did not find significantly different success rates in patients with different times of tube removal ($p = 0.8$). Success was achieved in 2 eyes with premature MCI extrusion and failure occurred in 1 eye with early BCI removal.

Eight of 9 eyes (88.8%) with partial success and 1 of 10 eyes (10%) with failure elected not to proceed to dacryocystorhinostomy. This may imply either sufficient resolution of symptoms (in the partial success group) or lack of desire for further surgery.

CONCLUSIONS

MCI had virtually the same complete success rate as BCI, higher partial success rate than BCI, and lower failure rate than BCI associated with less manipulation of the nasolacrimal drainage system at the time of tube insertion and removal for NLDS in adults. The MCI procedure is also easier to perform. We found more failures in the BCI than MCI groups. It is, however, not clear whether this is because of more severe preoperative NLDS or more manipulation and injury during a BCI. A prospective trial comparing these two types of nasolacrimal drainage system intubations, with special consideration to the preoperative severity of obstruction, should answer this question.

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