Klinische Monatsblätter für
Augenheilkunde

2020
Volume 237
Page 20–28

Translation from
German

Reprint

Intubation Systems in Lacrimal Drainage Surgery – a Current Overview

Alexander Rokohl
Guo Yongwei
Joel Mor
Loreck Niklas
Konrad Koch
Ludwig Heindl

ISSN 0023-2165

Thieme

Thieme

Intubation Systems in Lacrimal Drainage Surgery – a Current Overview

Intubationssysteme in der Tränenwegchirurgie – eine aktuelle Übersicht

Authors
Alexander C. Rokohl[1], Yongwei Guo[1], Joel M. Mor[1], Niklas Loreck[1], Konrad R. Koch[1], Ludwig M. Heindl[1,2]

Affiliations
1 Department of Ophthalmology, Cologne University Medical School and Medical Centre, Cologne, Germany
2 Centre for Integrated Oncology (CIO) Aachen – Cologne – Bonn – Düsseldorf, Cologne, Germany

Key words
microendoscopic lacrimal drainage surgery, transcanalicular, Lester Jones Tube, tear duct stents, dacryocystorhinostomy, tear duct obstruction, epiphora

Schlüsselwörter
mikroendoskopische Tränenwegchirurgie, transkanalikulär, Lester Jones, Tränenwegintubate, Dakryozystorhinostomie, Tränenwegobstruktion, Epiphora

received 7.8.2019
accepted 19.9.2019

Bibliography
DOI https://doi.org/10.1055/a-0992-9966
Published online 26.11.2019 | Klin Monatsbl Augenheilkd 2020; 237: 20–28 © Georg Thieme Verlag KG Stuttgart · New York | ISSN 0023-2165

Correspondence
Alexander C. Rokohl
Department of Ophthalmology, Cologne University Medical Centre
Kerpener Str. 62, 50937 Cologne, Germany
Phone: +49 (0) 22 14 78 43 00, Fax: +49 (0) 22 14 78 50 94
alexander.rokohl@gmail.com

ABSTRACT

The advent of microendoscopes in lacrimal duct surgery has paved the way for the adoption of novel transcanalicular anatomy-sparing surgical procedures, for which a variety of lacrimal duct intubation systems have been developed. Depending on the location and extent of the lacrimal duct stenosis, surgeons can perform bicanaliculoanular, monocanalicular, monocanaliculonasal, bicanalicular or bicanaliculonasal intubation, either as stand-alone techniques or in combination. While perforated punctum plugs are employed in isolated intubation of the lacrimal points, strictly monocanalicular intubation can be realised with a Mini-Monoka®. Monocanaliculonasal intubation systems in ophthalmic surgery include the Monoka (wide-collarette), Fayet Monoka (Crawford), self-threading Monoka (Ritleng®), Masterka®, and the LacriJet®. The bicanaliculonasal intubation systems comprise various BIKA® systems, the Ritleng intubation system, the Crawford Intubation Set, and the FCI Nunchaku®. Both mono- as well as bi-canaliculonasal intubation systems are indicated in any type of canalicular obstruction, stenoses and laceration, as well as in saccular and postsaccular stenoses after re-establishing patency and following dacryocystorhinostomy (DCR). Conjunctivodacryocystorhinostomy (CDCR), for example, can be fashioned with standard Lester Jones Tubes, Metaireau® Tubes or StopLoss® Jones Tubes. Although the evidence from trials is inconclusive and lacrimal duct intubation should therefore not be deemed mandatory, most ophthalmic surgeons still rely on it, despite higher cost and slightly longer operating times. In most cases, the surgeon will ultimately choose the intubation system based on the type of intubation, cost and personal preference and experience.

ZUSAMMENFASSUNG

Mit dem Einsatz von Mikroendoskopen in der Tränenwegchirurgie und dem dadurch bedingten Einzug der neueren, transkanalikulären, anatomieerhaltenden Operationsverfahren wurden verschiedenste Tränenwegintubationssysteme entwickelt. Je nach Lokalisation und Ausmaß der Tränenwegstenose können bikanalikuloanuläre, monokanalikuläre, monokanalikulonasale, bikanalikuläre und bikanalikulonasale Intubationstechniken und -systeme sowie Kombinationen daraus zum Einsatz kommen. Der isolierten Intubation der Tränenpünktchen dienen perforierte Punctum Plugs, während eine rein monokanalikuläre Intubation mit einer Mini-Monoka erfolgen kann. Als monokanalikulonasale Intubationssysteme stehen neben der Monoka (Wide-Collarette-Typ), der Monoka von Fayet (Crawford-Typ), der selbsteinfädelnde Monoka (Ritleng-Typ), der Masterka sowie der LacriJet für den ophthalmoplastischen Chirurgen zur Auswahl. Zu den bikanalikulonasalen Intubationssystemen zählen verschiedene BIKA-Sys-

teme, das Ritleng-Intubationssystem, das Crawford-Intubationsset und der FCI Nunchaku. Indikationen sowohl für monokanalikulonasale als auch bikanalikulonasale Intubationssysteme stellen kanalikuläre Obstruktionen, Stenosen oder Lazerationen aller Art sowie sakkale und postsakkale Obstruktionen und Stenosen nach deren Eröffnung oder nach einer Dakryozystorhinostomie (DCR) dar. Bei einer Konjunktivodakryozystorhinostomie (CDCR) können bspw. die klassischen Lester Jones Tubes, Metaireau Tubes oder die StopLoss Jones Tubes verwendet werden. Obwohl die Studienlage nicht eindeutig ist und daher eine Tränenwegintubation nicht als obligat angesehen werden darf, verzichten die meisten Ophthalmochirurgen trotz höherer Kosten und einer geringfügig längeren Operationsdauer in den meisten Fällen nicht auf eine solche. Für welches Intubationssystem der Operateur sich letztendlich entscheidet, hängt in den meisten Fällen von der gewählten Intubationsform, den Kosten sowie seinen persönlichen Präferenzen und Erfahrungen ab.

Introduction

Watery eye is a condition commonly faced by ophthalmologists in their daily practice. Its leading symptom, epiphora, can severely reduce quality of life and have a massive impact patients' daily life [1, 2]. In addition to changes in the tear film, eyelid malposition and hypersecretion, disorders of the lacrimal ducts, especially lacrimal duct stenoses and injuries, are one of the main causes of epiphora [3, 4]. The successful treatment of these lacrimal pathologies with largely preserved function was first achieved with external dacryocystorhinostomy (DCR), first described by Addeo Toti in the early 20th century, as well as with internal endonasal DCR according to West [4 – 6]. Both techniques became gold standards and remain in high standing today [5]. In addition to numerous modifications of these procedures, lacrimal surgery has also seen the advent of various minimally invasive techniques in recent years, not least as a result of the pioneering work of Meyer-Rüsenberg and Emmerich [5, 7]. Use of microendoscopes and lasers has reduced the burden of suffering of affected patients [2, 4 – 20]. With the introduction of the more recent transcanalicular surgical procedures, a broad range of intubation techniques were developed, such as the Münster intubation technique, and use of silicone intubation devices in lacrimal surgery saw a rapid increase [7, 10]. Depending on the location and extent of the lacrimal stenoses and injuries, different types of intubation are available today [7]. A distinction is made between bicanaliculoanular, monocanalicular, monocanaliculonasal, bicanalicular and bicanaliculonasal intubation techniques as well as combined techniques such as conjunctivodacryocystorhinostomy (CDCR) (▶ **Table 1**) [4, 19, 21, 22].

In recent years, new tear duct intubation devices for temporary splinting and recurrence prophylaxis of the tear ducts for a wide variety of intubation techniques, indications and surgical procedures have been developed and established in tear duct surgery (▶ **Table 1**) [22 – 24]. In particular, the working group headed by Busse from Münster have done outstanding pioneering work in this field [25 – 30]. This paper provides an up-to-date overview of the most common and popular tear duct intubation devices, their indications, special features, benefits, and drawbacks.

Intubation Systems for the lacrimal Points

Perforated punctal plugs in various sizes are available for the treatment of partial occlusion at the lacrimal point and recurrent lacrimal point stenosis (▶ **Fig. 1**) [23, 24]. These punctal plugs have a central lumen allowing drainage of tear fluid into the lacrimal canaliculus [23, 24]. They also have a bevelled cap for a perfect anatomical fit [23, 24]. Punctal plugs are made of medical silicone [23, 24]. Moreover, these plugs are coated with polyvinylpyrrolidone (PVP) [23, 24], a special surface finish to improve the hydrophilic properties of the silicone [23, 24]. The benefit of this PVP surface finish is optimised tear drainage efficiency as well as the minimisation of secretion deposits on the inner and outer surface of the perforated plug [23, 24]. Perforated punctal plugs are available in various sizes and sutureless implantation is quick, easy and without complications using a preloaded inserter [23, 24].

Monocanalicular Intubation Systems

The L-shaped Mini-Monoka has been the gold standard for monocanalicular intubation of the lacrimal duct. The long section of the Mini-Monoka probe is 40 mm long with a diameter of 0.64 mm

▶ **Table 1** Various types of intubation and a selection of applicable intubation systems.

Type of intubation	Intubation system
Lacrimal points	Perforated Punctal Plugs
Monocanalicular	Mini-Monoka
Monocanaliculonasal	Monoka (Wide-Collarette type)
	Monoka of Fayet (Crawford type)
	Self-threading Monoka (Ritleng type)
	Masterka
	LacriJet
Bicanalicular	Self-Retaining Set II® (SRS II)
Bicanaliculonasal	BIKA
	Infant BIKA
	Infant BIKA II
	BIKA 1.18
	BIKA for DCR
	FCI Nunchaku
	Ritleng intubation system
	Crawford intubation set
Conjunctivodacryocystorhinostomy	Metaireau tube
	Lester Jones tube
	StopLoss Jones tube

▶ **Fig. 1** Perforated punctal plugs in various sizes. Source: FCI S. A. S. – France Chirurgie Instrumentation, Paris.

(▶ **Fig. 2**) [23, 24]. The short section has a small, plug-like end with a 2 mm diameter (lacrimal punctal end plate) that serves to anchor the device without suturing to the lacrimal point [23, 24]. The Mini-Monoka is made of medical silicone and is available both with and without PVP coating [23, 24]. The typical indication is a monocanalicular injury as well as status post obstruction or stenosis of the distal 2/3 of the canaliculi. The LacriJet, which will be discussed in more detail later on, is now also available for this indication [23, 24].

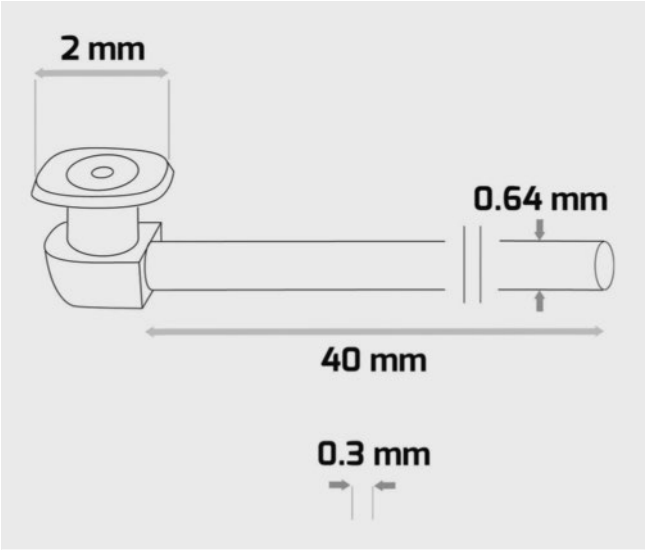
Monocanaliculonasal Intubation Systems

Ophthalmic surgeons can choose from these monocanaliculonasal intubation systems: Monoka (Wide-Collarette type), Monoka of Fayet (Crawford type), the self-threading Monoka (Ritleng type), the Masterka, and the LacriJet (▶ **Table 1**) [23, 24, 31, 32]. Monocanaliculonasal intubation systems are indicated in all types of monocanalicular obstructions, stenoses and lacerations, as well as saccal and postsaccal obstructions and stenoses post reopening or DCR [31 – 33].

The Monoka intubation system is structured quite similarly to the Mini-Monoka (▶ **Fig. 3**) [23, 24]. Apart from the different sizes, the long end has an atraumatic rounded metal probe attached to it via a small silicone tube [23, 24]. This metal probe is available in an 80 mm length for adults and in 60 mm for children [23, 24]. All models have the same diameter of 0.64 mm [23, 24]. The Monoka is made of silicone and is available in different plug sizes as well as some with PVP coating [23, 24]. Implantation is very straightforward. After inserting the metal probe into the lacrimal canaliculus to be intubated until it reaches the nasal cavity, the probe is pulled out of the nasal cavity and the monocle brought into the correct position until it is firmly seated without sutures. The metal probe is then cut off and the silicone tube shortened [23, 24].

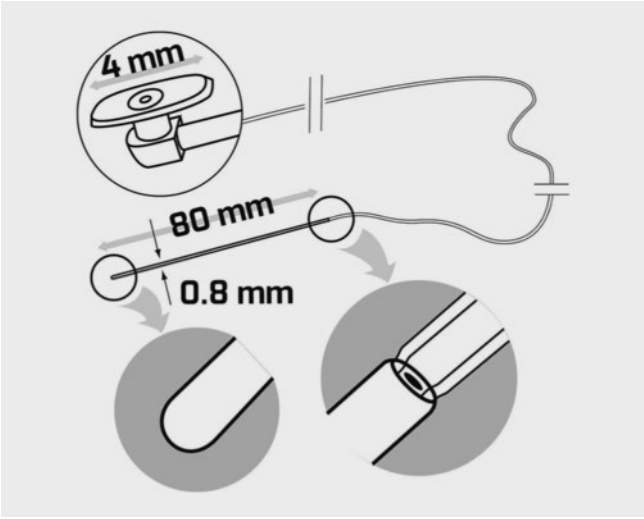
The Monoka of Fayet (Crawford type) comprises a Monoka connected to a metal probe via a silicone tube at the long end (▶ **Fig. 4**) [23, 24]. This probe has an atraumatic end in olive form [23, 24]. The Monoka of Fayet is also available with PVP coating and in various sizes [23, 24]. The Monoka of Fayet is inserted just like a regular Monoka (Crawford type).

The self-threading Monoka (Ritleng type) is a PVP or silicone Monoka connected at the long end to a PEEK (polyetheretherketone) guide thread (▶ **Fig. 5**) [23, 24]. After inserting a hollow Ritleng probe through the lacrimal canaliculus into the nasal cavity, the thin PEEK thread is threaded, then pulled out of the nasal cavity with a hook [23, 24]. The hollow Ritleng probe is then withdrawn, leaving only the PEEK thread in place [23, 24]. Then, by pulling on the PEEK thread, the Monoka is pulled to the right place and its fixation head ensures sutureless seating. The PEEK thread is then cut off.

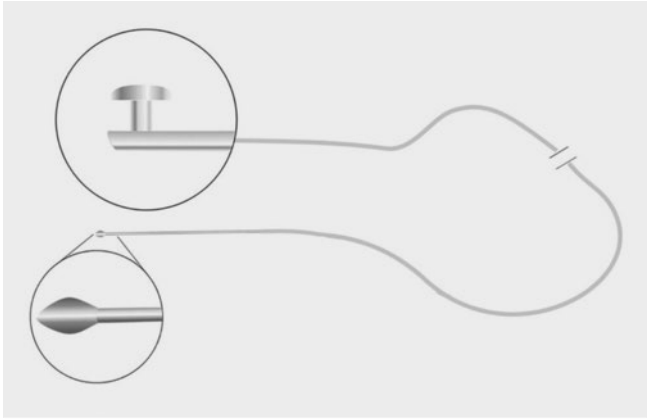


▶ **Fig. 2** Schematic presentation of a Mini-Monoka. Source: FCI S. A. S. – France Chirurgie Instrumentation, Paris.

The Masterka is a hollow silicone tube with a lacrimal punctal end plate at the distal end [23, 24]. The Masterka is mounted on a thin metal guide probe with a small metal handle (▶ **Fig. 6**) [23, 24]. Unlike intubation with the Monoka, in which the metal intubation probe is inserted in the lacrimal point and pulled out through the nose by the thread or the metal probe, in tear duct intubation with the Masterka nothing is pulled out through the nose [23, 24]. Instead, the Masterka, which is mounted on a metal probe, is inserted via the lacrimal canaliculi into the nasolacrimal duct and anchored at the lacrimal point by a kind of sutureless punctal plug. The metal guide probe is then pulled out distally. The Masterka is made of silicone and is available in different



▶ **Fig. 3** Monoka (Wide-Collarette type). Source: FCI S. A. S. – France Chirurgie Instrumentation, Paris.



▶ **Fig. 4** Monoka of Fayet (Crawford type) Source: FCI S. A. S. – France Chirurgie Instrumentation, Paris.

lengths [23, 24]. Indications include pre- and postsaccal stenoses or injuries of a lacrimal canaliculus in all segments, particularly when treatment with probes is not possible.

Bruno Fayet, a French ophthalmologist from Paris, developed the Masterka a few years ago in collaboration with FCI Ophthalmics [23, 24]. Basically, the LacriJet can be regarded as the continued development of the Masterka and is intended to shorten the operating time considerably once again (▶ **Fig. 7**) [23, 24]. The result is a classic Monoka in 7 different lengths (15–50 mm), which is available pre-loaded in a disposable instrument, the so-called introducer [23, 24]. This introducer has a metal probe with a longitudinal slit concealing the Monoka inside [23, 24]. Once the metal probe of the introducer has been correctly positioned in the target position after probing the tear ducts, the probe can be retracted into the handpiece while at the same time the Monoka is released and remains in the desired position [23, 24]. The LacriJets in particular, with their very short Monokas (15 and 20 mm), are also suitable for purely monocanalicular intubation [23, 24].

Bicanaliculonasal Intubation Systems

Potential indications for bicanaliculonasal intubation systems include status post opening of mono- and bicanalicular obstructions, stenoses or lacerations of any kind, as well as saccal and postsaccal obstructions or stenoses after their opening or after DCR [6, 33, 34]. Moreover, bicanalicular intubation is an important surgical strategy when performing DCR, as the free opening of the internal ostium, i.e., the opening of the canaliculi into the anastomosis, can be precisely assessed after intubation.

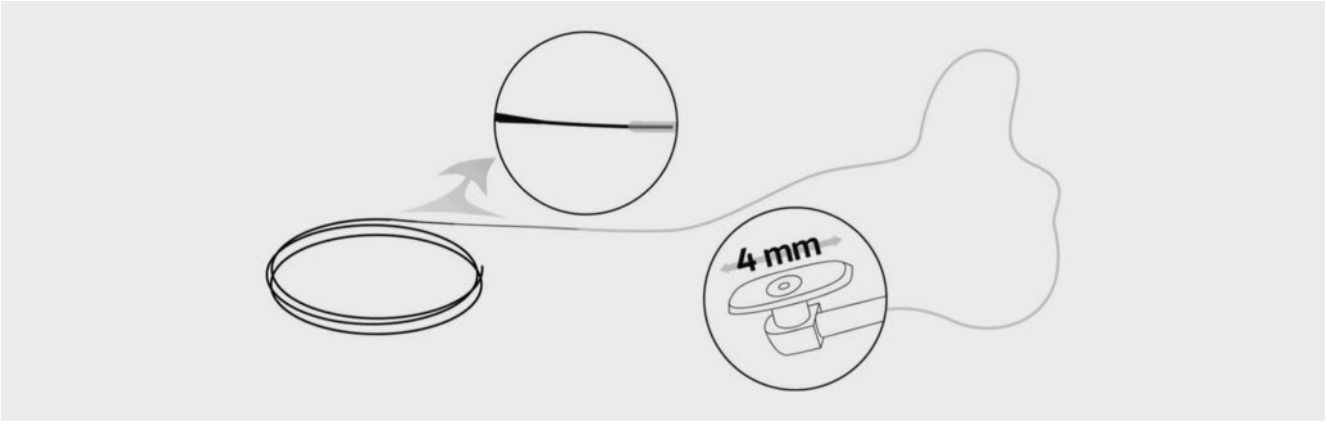
Bicanaliculonasal intubation systems available to surgeons include various BIKA systems, the Ritleng intubation system, the Crawford intubation set and the FCI Nunchaku (▶ **Table 1** and **2**) [23, 24].

The BIKA intubation systems were the first models designed for bicanaliculonasal intubation. These systems are preferred in congenital tear duct stenosis and dacryocystorhinostomy (DCR). The BIKA comprises 2 metal probes, each 80 mm long and 0.85 mm in diameter, with an atraumatic round tip (▶ **Fig. 8**) [23, 24]. The 2 metal probes are connected by a small tube with a diameter of 0.64 mm made of pure medical silicone [23, 24]. The metal probes are embedded in the silicone tube ensuring a smooth transition [23, 24]. Other versions of the BIKA are also available, which are similar in structure but differ in size and length (▶ **Table 2**) [23, 24]. Some models are also available with an optional PVP coating (▶ **Table 2**) [23, 24].

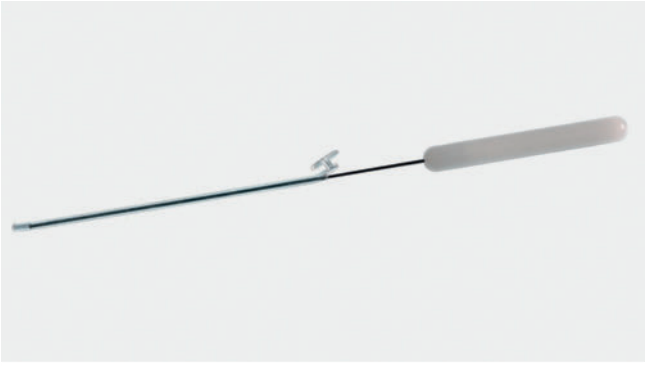
The BIKA is used for so-called U-intubation, which corresponds to bicanaliculonasal splinting of the lacrimal drainage system. Once the stenoses have been opened up, the metal probes are advanced through both lacrimal canaliculi and the nasolacrimal duct to the orifice in the nasal cavity. Both metal probes are then removed, and the silicone tubes are linked together in the nasal cavity and anchored to the nasal mucosa as needed. The inserted silicone tube thus splints the entire efferent lacrimal drainage system.

The Crawford intubation system comprises two 115 mm long atraumatic metal probes with an olive-shaped head at the distal end (▶ **Fig. 9**) [23, 24]. These two probes are connected by a silicone tube (diameter 0.64 mm) [23, 24]. This intubation system is inserted the same way as in BIKA intubation.

The Ritleng intubation system comprises a PVP or silicone tube (diameter 0.64 mm) and a PEEK guide thread [23, 24]. After inserting a hollow Ritleng probe through the lacrimal canaliculi into the nasal cavity, the thin PEEK thread is threaded, then pulled out of the nasal cavity with a hook. Alternatively, the so-called Jünemann probe preferred by Busse may be used here. The hollow Ritleng probe is then withdrawn, leaving only the PEEK thread in place. By pulling on the PEEK thread, the silicone tube is pulled into the correct position. The PEEK thread is then cut off. The second silicone tube is now inserted in the same way via the other canaliculus, with both legs now terminating in a U-shape in the main nasal cavity, where they can be secured in place. The Ritleng+ intubation system, a refinement of the Ritleng system, contains two 6 mm long, somewhat thicker segments (diameter



▶ **Fig. 5** Monoka (Ritleng type). Source: FCI S. A. S. – France Chirurgie Instrumentation, Paris.



▶ **Fig. 6** Masterka intubation system. Source: FCI S. A. S. – France Chirurgie Instrumentation, Paris.

▶ **Fig. 7** LacriJet intubation system made by FCI. Source: FCI S. A. S. – France Chirurgie Instrumentation, Paris.

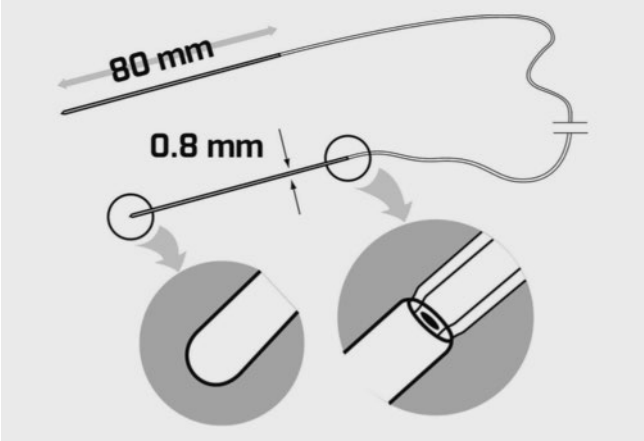
▶ **Table 2** Various BIKA intubates with their respective characteristics.

Name	Material	Length of metal probes	Diameter of metal probes	Diameter of silicone tubes
BIKA	Silicone (±PVP)	80 mm	0.85 mm	0.64 mm
Infant BIKA	Silicone	55 mm	0.40 mm	0.64 mm
Infant BIKA II	Silicone (±PVP)	60 mm	0.80 mm	0.64 mm
BIKA 1.18	Silicone	40 mm	0.70 mm	1.18 mm
BIKA for DCR	Silicone	53 mm	0.80 mm	0.94 mm

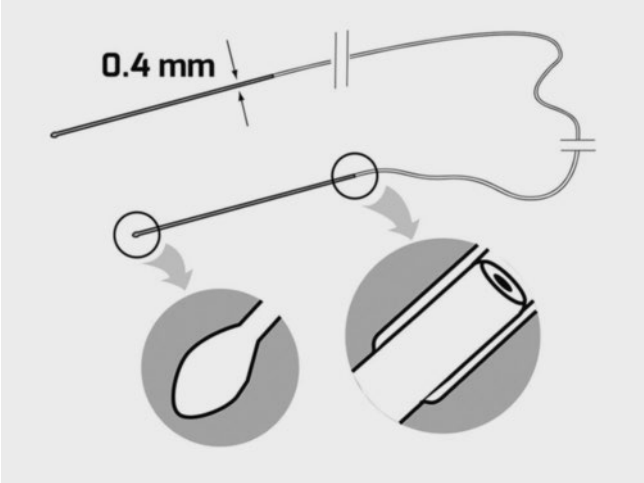
0.94 mm) which come to rest in the nasolacrimal duct, preventing it from slipping (▶ **Fig. 10**) [23, 24]. Fixation is therefore no longer required.

The design of the FCI Nunchaku resembles a kind of double Masterka (▶ **Fig. 11**) [23, 24]. The FCI Nunchaku comprises two hollow silicone tubes, each 1 mm in diameter and mounted on a metal probe with a small metal handle at the distal end [23, 24]. Both silicone tubes are also connected at the distal end [23, 24]. Intubation is the same as intubation with the Masterka, except that both canaliculi are probed and splinted one after the other. Splinting then corresponds to a U-shaped intubation anchored without sutures and not requiring nasal extraction. It is also available in two different lengths, 90 mm for children and 105 mm for adults [23, 24].

In the Münster technique, a lightly curved Jünemann blade probe is inserted via a lacrimal canaliculus to the orifice in the nasal cavity. A Prolene® thread is then advanced into the lower nasal passage via this probe and pulled out of the nose by means of a small strabismus hook. The probe is then removed. The indwelling thread now serves as a guide for a silicone tube, which is advanced a few centimetres onto the thread and then clamped to it. Pulling on the thread will insert the silicone tube into the lacrimal drainage system and out through the nose. The second end of the silicone tube is also inserted in this manner via the other canaliculus



▶ **Fig. 8** BIKA intubation system. Source: FCI S. A. S. – France Chirurgie Instrumentation, Paris.



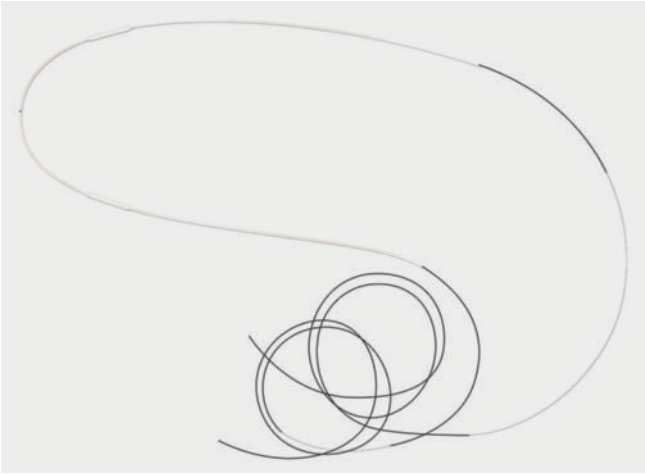
▶ **Fig. 9** Crawford intubation system. Source: FCI S. A. S. – France Chirurgie Instrumentation, Paris.

so that the intubation system emerges in the inferior nasal passage with both legs in a U-shape and is knotted there.

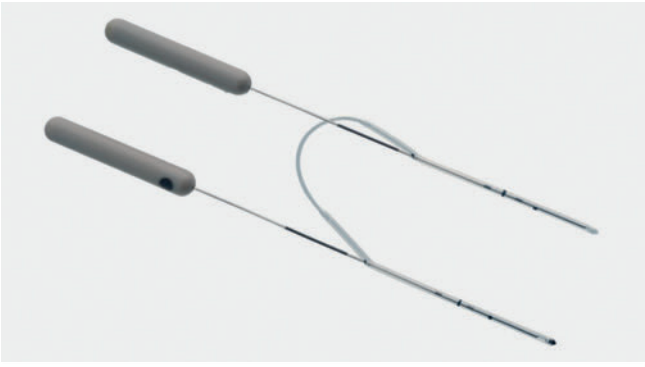
Bicanalicular Intubation Systems

The Self-Retaining Set II (SRS II), also known as an Autostable Intubation Set II, is used in the treatment of canalicular stenoses, lacerations and horizontal obstructions of the lacrimal duct [23, 24, 35]. The SRS II comprises a silicone tube of various lengths (25–40 mm) with barbs at both ends (▶ **Fig. 12**) [23, 24]. In addition, each end is fitted with a metal guide probe [23, 24]. SRS II positioning is facilitated by the probe in the tube. The canaliculi are probed one after the other. The barbs collapse during probing. When the lacrimal sac is reached, they deploy and secure the system. This intubation corresponds to a U-intubation.

A special form of bicanalicular intubation is the bicanaliculoanular technique ("ring intubation") [36, 37]. Typical indications



▶ **Fig. 10** Ritleng+ intubation system. Source: FCI S. A. S. – France Chirurgie Instrumentation, Paris.



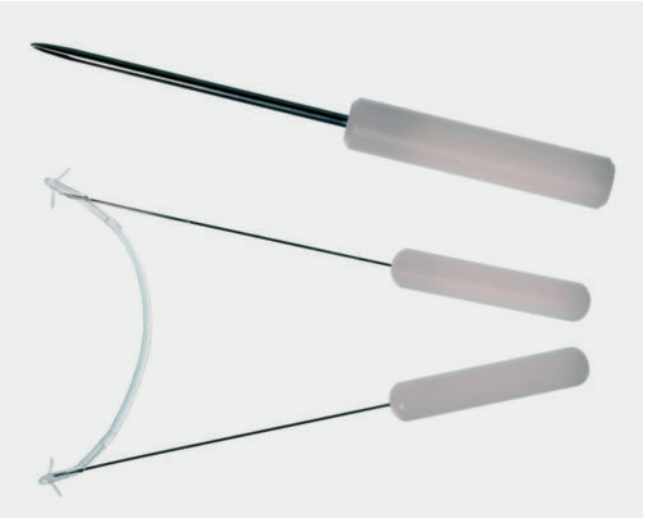
▶ **Fig. 11** FCI Nunchaku. Source: FCI S. A. S. – France Chirurgie Instrumentation, Paris.

of this technique are canalicular injuries [36, 37]. According to the technique of Murube del Castillo, retrograde probing is performed with a so-called pigtail probe (Worst probe) and a guide thread (e.g., Prolene) is introduced [36, 37]. A silicone tube – similar to the U-intubation – with a length of about 2.5 cm and a diameter of 0.64 mm – can then be threaded onto this thread and secured to it with a clamp. Traction on the guide thread will insert the silicone tube into the lacrimal canaliculi. After appropriate trimming, both ends are tied together and then the knot is pulled into the intact segment of a lacrimal canaliculus [36, 37].

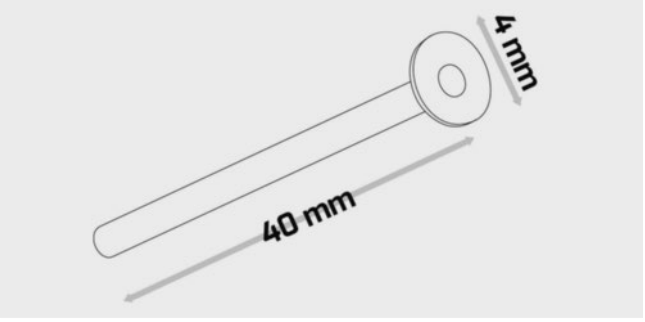
Intubation System for Conjunctivodacryocystorhinostomy (CDCR)

Indications for CDCR include absolute long-stretch canalicular stenosis as well as impossibility and failure of alternative techniques to restore lacrimal patency, e.g., as a secondary procedure following prior DCR [38]. For many years, the gold standard in CDCR was the classic Lester Jones tube [38, 39]. Over the years, various mod-

ifications of the original Jones tube have been developed [39]. These included the Putterman-Gladstone tube, Frost tubes, with a slightly textured outer surface, and elongated angle tubes designed to better fit the anatomy [39]. Medpor-coated intubation systems were designed to facilitate tube ingrowth thereby stabilising the tube [39]. Another alternative to the traditional Lester-Jones tubes made of Pyrex glass are the Metaireau tubes, which are made of silicone and are available both with and without PVP coating (▶ **Fig. 13**) [23, 24]. This is to prevent potential clogging of the tubes [39, 40]. However, the major complication with traditional Lester-Jones tubes is migration or extrusion of the tubes, e.g. when blowing one's nose, sneezing or rubbing one's eyes [39, 40]. In up to 50 % of patients, dislocation or extrusion of the Lester Jones tube occurred within a few years [38, 41]. However, none of the alternatives provided a satisfactory solution to the problem of potential dislocation and extrusion [39, 40]. This is why the StopLoss Jones Tube was developed [23, 24, 38, 39, 42]. It is made of Pyrex glass and has a flexible silicone flange at its distal end [23, 24, 38]. It comes in different lengths (9–22 mm) and flange sizes (▶ **Fig. 14**) [23, 24, 38]. Initially, it is implanted like a traditional Lester Jones tube [38]. However, at the end of the procedure, a silicone flange unfolds endonasally at the distal end to counteract dislocation [38, 39]. This implantation may also be performed in minimally invasive fashion without skin incision using a laser [38].



▶ **Fig. 12** Self-Retaining Set II (SRS II). Source: FCI S. A. S. – France Chirurgie Instrumentation, Paris



▶ **Fig. 13** Metaireau tube. Source: FCI S. A. S. – France Chirurgie Instrumentation, Paris.

Discussion

Due the broad range of intubation systems available, ophthalmic surgeons have many options for lacrimal duct intubation. First, surgeons must decide whether intubation should be carried out at all or whether they should refrain from intubation. For example, in case of traumatic lacrimal tract injury, which in most cases is localised at the canaliculi, the authors recommend splinting the lacrimal drainage system by intubation, e.g., by ring intubation according to Murube del Castillo [21, 36, 37]. Alternatively, bicanalicular intubation may also be performed as endonasal U-intubation or with the Self-Retaining Set II (SRS II) [35, 37]. A complication of any bicanalicular intubation can be slitting of the canaliculi with tearing of the lacrimal points due to endonasal fixation or knotting which was too tight [21, 37, 43]. If, on the other hand, the knot is tied too loosely, this may result in bothersome foreign body sensation and erosion of the conjunctiva or cornea [37]. Given these problems, some authors also prefer monocanalicular intubation [21, 32, 37, 43]. Here, the silicone tubing has an end plate designed to provide a stable permanent seating [37]. Long-term intubation, usually for about 3 months, to prevent stricture scarring with subsequent stenosis, is thus possible without any significant risk of injury to the canaliculi or lacrimal points [21, 32, 37, 43]. Both bicanalicular and monocanalicular intubation techniques have similar success rates in lacrimal drainage system injuries [21]. In stenoses of the lacrimal drainage system, the additional benefit of its intubation after opening the stenosis has not always been clearly demonstrated [33, 44]. Recent metaanalyses, for example, show a benefit for intubation of the lacrimal drainage system in external DCR [33]. On the other hand, no benefit of intubation has been shown for endonasal DCR [33]. Apart from the complications with lacrimal drainage system intubation already mentioned, another reason for refraining from intubation is the cost. In addition to slightly longer operating times, some monocanalicular intubation systems cost in the low 3-digit Euro range. In addition, before using such an intubation system, it is always necessary to consider how it can be removed a few months later. While for most adults this can be done quickly and without any problems using the slit lamp, children may even require general anaesthesia. Although intubation is not considered mandatory and results in both higher cost and longer operating time, most ophthalmic surgeons, including the authors, opt in favour of it in most cases [6, 31, 32]. If the surgeon decides to intubate, the systems listed above are available. All systems rely on medical silicone as their material [21, 23, 24]. Some have additional PVP coating. PVP coating appears to offer benefits at least for perforated punctal plugs [45]. Here, the PVP coating seems to result in better patency and thus greater reduction of epiphora symptoms [45]. For other intubation systems, however, the benefit of a PVP coating has not been clearly proven or even studied.

▶ **Fig. 14** StopLoss Jones tubes of various lengths. Source: FCI S. A. S. – France Chirurgie Instrumentation, Paris.

Initial studies show reduced short- and medium-term extrusion rates in CDCR for the StopLoss Jones tube, but long-term results are not yet available [39, 42, 46].

Whether surgeons decide to intubate and, if so, which system they ultimately use, depends in most cases primarily on the type of intubation, cost and their personal preferences and experience. Newer intubation systems supposedly shorten operating time, but of course every new system has its own learning curve, so there is always the potential for longer operating times and higher complication rates initially. It is up to each surgeon to decide whether it is worth switching to new systems that are potentially easier to handle and may shorten operating time.

Acknowledgements

All illustrations have been kindly provided by FCI S. A. S. – France Chirurgie Instrumentation, 20–22 rue Louis Armand, 75015 Paris, France.

Conflict of Interest

The authors declare that they have no conflict of interest.

References

[1] Shin JH, Kim YD, Woo KI et al. Impact of epiphora on vision-related quality of life. BMC Ophthalmol 2015; 15: 6. doi:10.1186/1471-2415-15-6

[2] Sipkova Z, Vonica O, Olurin O et al. Assessment of patient-reported outcome and quality of life improvement following surgery for epiphora. Eye (Lond) 2017; 31: 1664–1671. doi:10.1038/eye.2017.120

[3] Schargus M, Geerling G. [Diagnosis and treatment of the watering eye]. HNO 2017; 65: 69–84. doi:10.1007/s00106-016-0286-8

[4] Meyer-Rüsenberg HW, Emmerich KH. [Therapy options for diseases of the lacrimal ducts]. Ophthalmologe 2009; 106: 193. doi:10.1007/s00347-008-1903-z

[5] Meyer-Rüsenberg HW, Vujancevic S, Emmerich KH. [Current status of dacryocystorhinostomy]. Ophthalmologe 2009; 106: 205–207, 210–216. doi:10.1007/s00347-008-1904-y

[6] Mor JM, Matthaei M, Schrumpf H et al. Transcanalicular laser dacryocystorhinostomy for acquired nasolacrimal duct obstruction: an audit of 104 patients. Eur J Med Res 2018; 23: 58. doi:10.1186/s40001-018-0355-4

[7] Emmerich KH, Ungerechts R, Meyer-Rüsenberg HW. [Microendoscopic tear duct surgery]. Ophthalmologe 2009; 106: 194, 196–204. doi:10.1007/s00347-009-1938-9

[8] Uludag G, Yeniad B, Ceylan E et al. Outcome comparison between transcanalicular and external dacryocystorhinostomy. Int J Ophthalmol 2015; 8: 353–357. doi:10.3980/j.issn.2222-3959.2015.02.25

[9] Emmerich KH, Meyer-Rüsenberg HW, Simko P. [Endoscopy of the lacrimal ducts]. Ophthalmologe 1997; 94: 732–735

[10] Emmerich KH, Lüchtenberg M, Meyer-Rüsenberg HW et al. [Dacryoendoscopy and laser dacryoplasty: technique and results]. Klin Monatsbl Augenheilkd 1997; 211: 375–379. doi:10.1055/s-2008-1035151

[11] Meyer-Rüsenberg HW, Emmerich KH, Lüchtenberg M et al. [Endoscopic laser dacryoplasty. Methodology and outcome after 3 months]. Ophthalmologe 1999; 96: 332–334

[12] Steinhauer J, Norda A, Emmerich KH et al. [Laser canaliculoplasty]. Ophthalmologe 2000; 97: 692–695

[13] Emmerich KH, Meyer-Rüsenberg HW. [Endoscopic lacrimal duct surgery]. Ophthalmologe 2001; 98: 607–612

[14] Emmerich KH, Ungerechts R, Meyer-Rüsenberg HW. Possibilities and limits of minimal invasive lacrimal surgery. Orbit 2000; 19: 67–71

[15] Emmerich KH, Emmerich GM, Steinkogler FJ et al. [How did lacrimal endoscopy influence lacrimal surgery?]. Klin Monatsbl Augenheilkd 2010; 227: 559–563. doi:10.1055/s-0029-1245337

[16] Emmerich KH, Ungerechts R, Meyer-Rüsenberg HW. [Transcanalicular microendoscopic laser DCR: technique and results]. Klin Monatsbl Augenheilkd 2012; 229: 39–41. doi:10.1055/s-0031-1281942

[17] Mor JM, Guo Y, Koch KR et al. Transcanalicular diode laser-assisted dacryocystorhinostomy for the treatment of primary acquired nasolacrimal duct obstruction. J Vis Exp 2017. doi:10.3791/55981

[18] Avgitidou G, Koch KR, Heindl LM. [Minimally invasive therapy of lacrimal drainage system stenosis]. Klin Monatsbl Augenheilkd 2017; 234: 1183–1195. doi:10.1055/s-0043-115055

[19] Heindl LM. [Update on minimally invasive lacrimal drainage surgery]. Ophthalmologe 2017; 114: 396. doi:10.1007/s00347-016-0426-2

[20] Koch KR, Kühner H, Cursiefen C et al. [Significance of transcanalicular laser assisted dacryocystorhinostomy in modern lacrimal drainage surgery]. Ophthalmologe 2015; 112: 122–126. doi:10.1007/s00347-014-3179-9

[21] Struck HG. [Lacrimal system lacerations and their surgical repair]. Ophthalmologe 2009; 106: 223–228. doi:10.1007/s00347-008-1906-9

[22] Böhm M, Heichel J, Bredehorn-Mayr T et al. [Prognostic value of lacrimal duct diagnostics after tube removal: retrospective analysis of risk of relapse during the first postoperative year after transcanalicular lacrimal duct surgery with silicone tubing]. Ophthalmologe 2017; 114: 424–431. doi:10.1007/s00347-017-0441-y

[23] Im Internet: https://fciworldwide.com/products/oculoplasty-934/epiphora; Stand: 23.07.2019

[24] Im Internet: https://ruck-gmbh.de/de/produkte/produkte-nacheinsatzbereichen/traenenwegschirurgie/; Stand: 23.07.2019

[25] Prokosch V, Busse H, Thanos S et al. [Impact of age on success rate of lacrimal duct irrigation with silicone tube intubation in connatal lacrimal duct stenosis]. Klin Monatsbl Augenheilkd 2013; 230: 1020–1024. doi:10.1055/s-0033-1350785

[26] Lawin-Brüssel CA, Hüttenbrink KB, Krebs A et al. [Endonasal implantation of a silicon mold improves the long-term outcome of revision surgery in lacrimal duct stenoses]. Klin Monatsbl Augenheilkd 1995; 206: 33–38. doi:10.1055/s-2008-1035402

[27] Busse H. Indications and techniques of implantation of hydrophilic lacrimal tubes. J Maxillofac Surg 1982; 10: 116–118

[28] Emmerich KH, Busse H, Meyer-Rüsenberg HW. [Dacryocystorhinostomia externa. Technique, indications and results]. Ophthalmologe 1994; 91: 395–398

[29] Busse H. [First results with hydrophile tear duct prosthesis (author's transl)]. Klin Monatsbl Augenheilkd 1979; 174: 215–218

[30] Busse H, Hollwich F, Jünemann G. [Plastic and reconstructive surgery of the lacrimal apparatus]. Ber Zusammenkunft Dtsch Ophthalmol Ges 1979: 111–121

[31] Koch KR, Cursiefen C, Heindl LM. [Transcanalicular laser dacryocystorhinostomy: one-year-experience in the treatment of acquired nasolacrimal duct obstructions]. Klin Monatsbl Augenheilkd 2016; 233: 182–186. doi:10.1055/s-0041-106653

[32] Koch KR, Cursiefen C, Heindl LM. [Minimally invasive bypass surgery for nasolacrimal duct obstruction: transcanalicular laser-assisted dacryocystorhinostomy]. Ophthalmologe 2017; 114: 416–423. doi:10.1007/s00347-017-0466-2

[33] Ing EB, Bedi H, Hussain A et al. Meta-analysis of randomized controlled trials in dacryocystorhinostomy with and without silicone intubation. Can J Ophthalmol 2018; 53: 466–470. doi:10.1016/j.jcjo.2017.12.006

[34] Fayers T, Dolman PJ. Bicanalicular silicone stents in endonasal dacryocystorhinostomy: results of a randomized clinical trial. Ophthalmology 2016; 123: 2255–2259. doi:10.1016/j.ophtha.2016.06.026

[35] Heichel J, Struck HG, Viestenz A. [Primary reconstruction of lacrimal ducts after trauma – bicanaliculonasal intubation using autostable tubes]. Klin Monatsbl Augenheilkd 2019. doi:10.1055/a-0839-5172

[36] Ruprecht KW. [Ring-intubation set for bicanalicular intubation (Murube del Castillo technic)]. Klin Monatsbl Augenheilkd 1983; 183: 509–510. doi:10.1055/s-2008-1054996

[37] Koch KR, Kopecky A, Heindl LM. [Management of periocular soft tissue injuries]. Klin Monatsbl Augenheilkd 2016; 233: 1071–1087. doi:10.1055/s-0033-1358242

[38] Guo Y, Koch KR, Heindl LM. Transcaruncular laser-assisted StopLoss Lester Jones tube surgery for lacrimal canalicular obstructions. Graefes Arch Clin Exp Ophthalmol 2019; 257: 1569–1570. doi:10.1007/s00417-019-04331-0

[39] Steele EA. Conjunctivodacryocystorhinostomy with Jones tube: a history and update. Curr Opin Ophthalmol 2016; 27: 439–442. doi:10.1097/ICU.0000000000000287

[40] Sendul SY, Cagatay HH, Dirim B et al. Comparison of Medpor coated tear drainage tube versus silicon tear drainage tube in conjunctivodacryocystorhinostomy: problems and solutions. ScientificWorldJournal 2014; 2014: 164834. doi:10.1155/2014/164834

[41] Lim C, Martin P, Benger R et al. Lacrimal canalicular bypass surgery with the Lester Jones tube. Am J Ophthalmol 2004; 137: 101–108. doi:10.1016/j.ajo.2003.08.002

[42] Bagdonaite L, Pearson AR. Twelve-year experience of Lester Jones tubes-results and comparison of 3 different tube types. Ophthalmic Plast Reconstr Surg 2015; 31: 352–356. doi:10.1097/IOP.0000000000000340

[43] Anderson RL, Edwards JJ. Indications, complications and results with silicone stents. Ophthalmology 1979; 86: 1474–1487

[44] Kalin-Hajdu E, Cadet N, Boulos PR. Controversies of the lacrimal system. Surv Ophthalmol 2016; 61: 309–313. doi:10.1016/j.survophthal.2015.12.003

[45] Malet T, Challier B, David N et al. Clinical and scintigraphic comparison of silicone and polyvinylpyrrolidone coated silicone perforated plugs. Br J Ophthalmol 1998; 82: 1416–1419. doi:10.1136/bjo.82.12.1416

[46] Bagdonaite L, Pearson AR. Early experience with the StopLoss Jones tube. Orbit 2015; 34: 132–136. doi:10.3109/01676830.2015.1014507