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Transcanalicular Dacryocystorhinostomy

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Imaging procedures such as dacryocystography, computed tomography, magnetic resonance imaging, high-resolution ultrasound, and scintigraphy are of great importance in diagnosing mechanical dacryostenosis. The aim is locating the mechanical stenosis and allowing for selection of a suitable operative procedure to eliminate the lacrimal obstruction. However, none of the imaging procedures enable direct visualization of pathologic changes such as mucosal or neoplastic changes, dacryoliths, or foreign bodies. The use of rigid endoscopes for preoperative endonasal assessment of the nasal mucosa or for postoperative evaluation has yielded important results for diagnosis and management of diseases of the lacrimal passage for many years.

Dacryoendoscopy

The need to directly visualize pathologic changes in the lacrimal passages led to the development of rigid and flexible endocanalicular endoscopes.[1] Because of the narrow lumen of the canaliculus, which is barely more than 1 mm in diameter, the first endoscopes could not provide a satisfactory image quality and thus did not represent a true advancement in diagnostics. Superfine flexible endoscopes (with a diameter of 0.3–0.7 mm) resulting as a modification of gastroduodenal endoscopes were developed for transcanalicular diagnostics.[2,3] With a diameter of 0.3 mm, an image of 1500 pixels could be transmitted with fair quality, but details could not be interpreted and only a rough outline could be attained. By extending the diameter to 0.5 or 0.7 mm, 3000 or 6000 pixels could be transmitted, resulting in a much better image.

Technical Equipment

A modified Juenemann probe was used as the first flexible diagnostic endoscope (Figure 13.1) along with an irrigation channel.[2,4] The exterior diameter was 0.9 mm. The endoscope had a 70° angle view and a 0° direction view. It was illuminated by a Xenon cold light source (Figure 13.2)

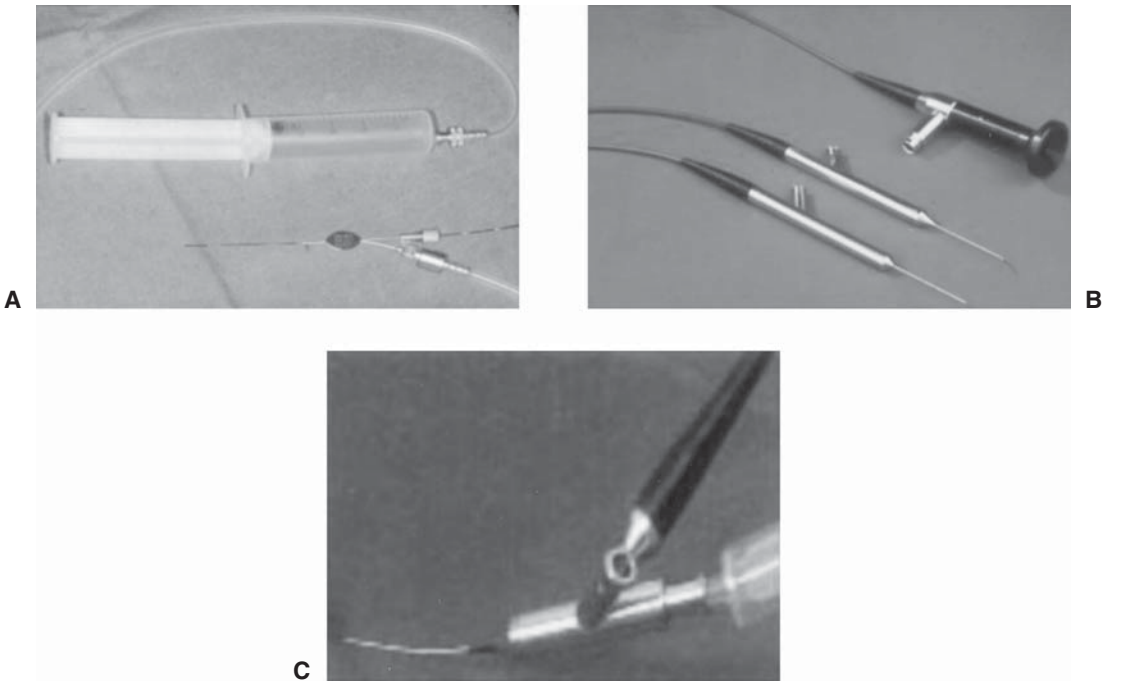

FIGURE 13.1. Development of the dacryoendoscopes. **(A)** Modified Juenemann probe, 3000 pixels. **(B)** Rigid dacryoendoscope (Vitroptic), 6000 pixels. **(C)** Flexible Vitroptic T, 6000 pixels.

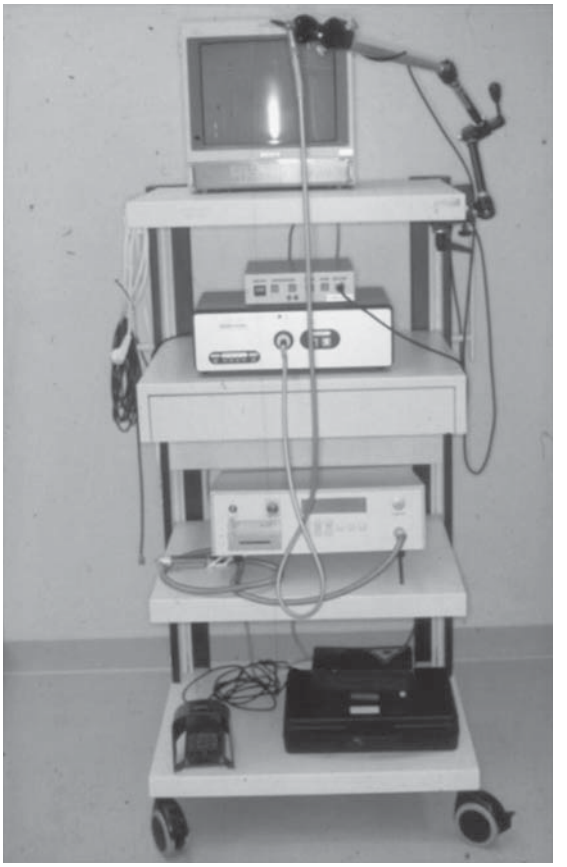

FIGURE 13.2. Endoscopic system (from the top to the bottom): monitor and camera, Xenon light source, erbium:YAG laser, video recorder.

and was connected to a camera by a TV adapter. The camera had a residual light amplification and a high shutter speed of up to 1/2,000,000 of a second. The picture was visible on a high-performance monitor and recorded simultaneously through a video output and documented on a video recorder. It is important to understand that the quality of the actual video picture is much better than the pictures in the text, which were taken from a still video picture. With the exception of the configuration of the endoscopes, e.g., the Vitroptic (Figure 13.1C), the system is unchanged. Future digitalization of the picture may improve its quality.

Performing Dacryoendoscopy

Before performing dacryoendoscopy, the puncta must be dilated (Figure 13.3). Using an astringent solution, the passage is irrigated gently and the endoscope is inserted via the upper or lower canaliculus. The endoscope is advanced forward as far as possible to reach the stenosis or the inferior turbinate. It is then retracted, allowing for a complete evaluation of the lacrimal passage. Retracting and advancing the endoscope with simultaneous irrigation requires a certain amount of practice to obtain quality images. An unobstructed view demonstrates the normal anatomic sequence of transcanalicular endoscopy,

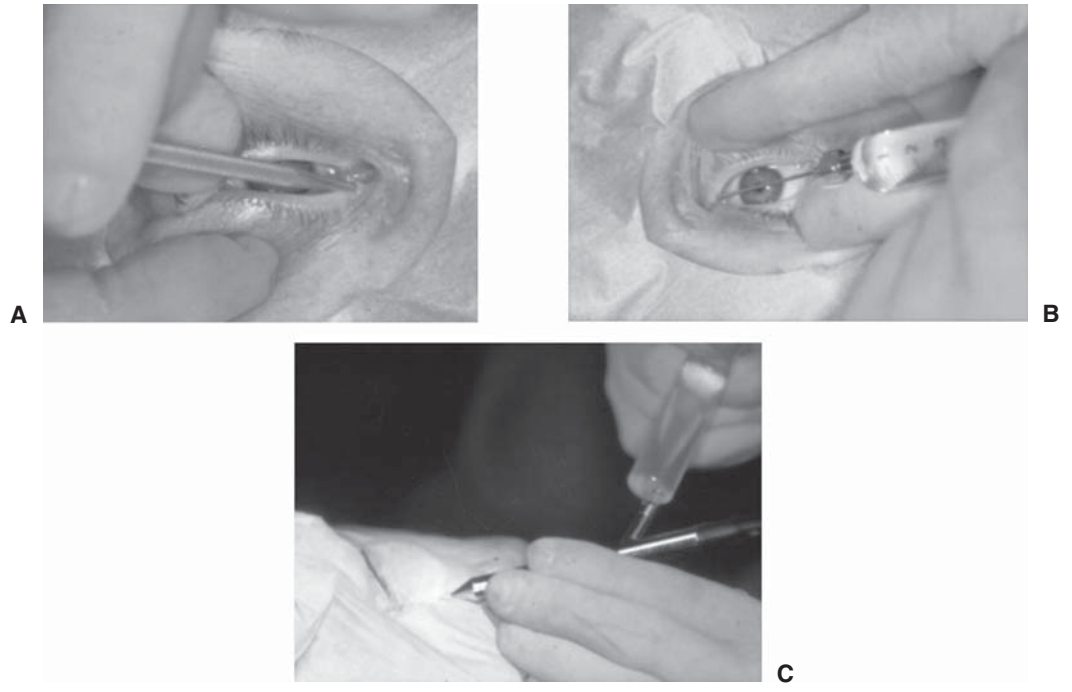

FIGURE 13.3. Steps of dacryoendoscopy. **(A)** Dilating punctum. **(B)** Irrigation. **(C)** Endoscopy and irrigation.

showing canaliculus, lacrimal sac, nasolacrimal duct, and nasal mucosa of the inferior turbinate.

The canalicular mucosa appears white and is quite different from the reddish color of the mucosa of the lacrimal sac. The nasolacrimal duct can be recognized by its narrow shape and its reddish color. The nasal cavity is an intensively red structure, with a smooth surface and large width (Figure 13.4).

Endoscopy permits differentiation of abnormal findings such as membranes, scars, acute or chronic mucosal inflammation, and foreign bodies. Even small blood deposits on the mucosa resulting from manipulation of the lacrimal passage are obvious (Figure 13.5).

From the results of the endoscopy, an appropriate operative procedure can be selected. In Germany, some centers have performed more than 10,000 endoscopic procedures. Injuries caused by the endoscope are comparable to other surgical interventions of the lacrimal passage, such as irrigation or intubation. In general, it is possible to perform a dacryoendoscopy with anesthetizing eye drops, irrigation of the lacrimal passage with 4% cocaine solution, and an anesthetizing nose spray. Most endoscopy procedures are performed under general anesthesia.

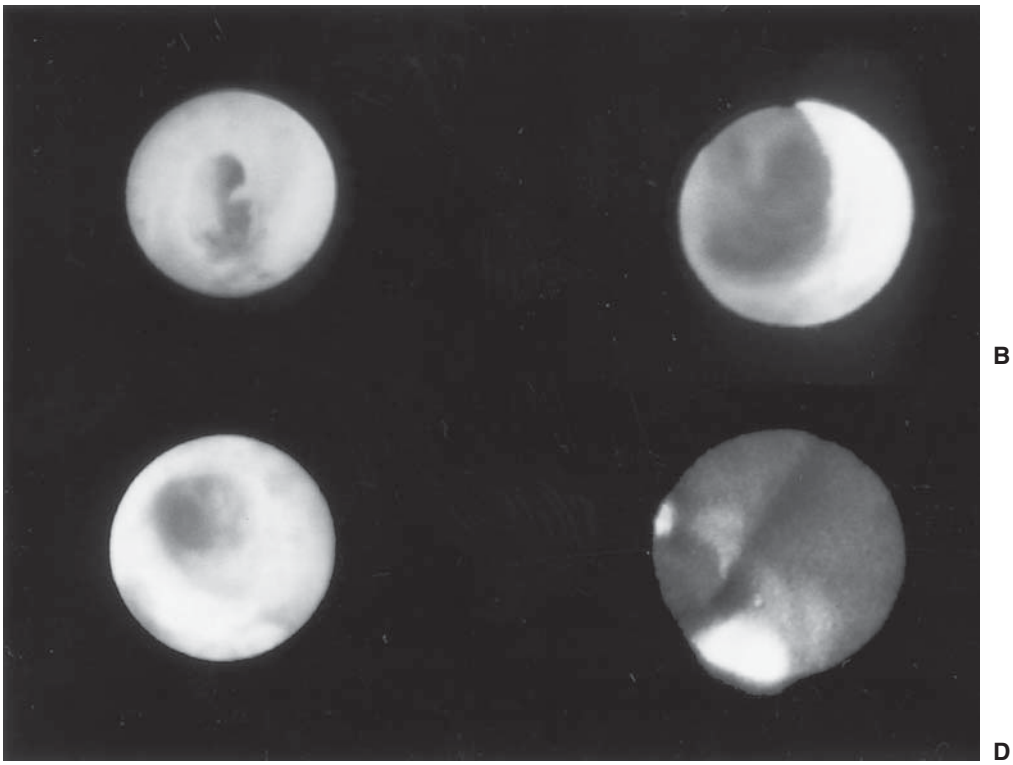

FIGURE 13.4. Endoscopic view of the normal anatomy of the lacrimal passage. **(A)** Canaliculus. **(B)** Rosenmüeller's valve. **(C)** Passage from sac to nasolacrimal duct. **(D)** Nasal cavity and inferior turbinate.

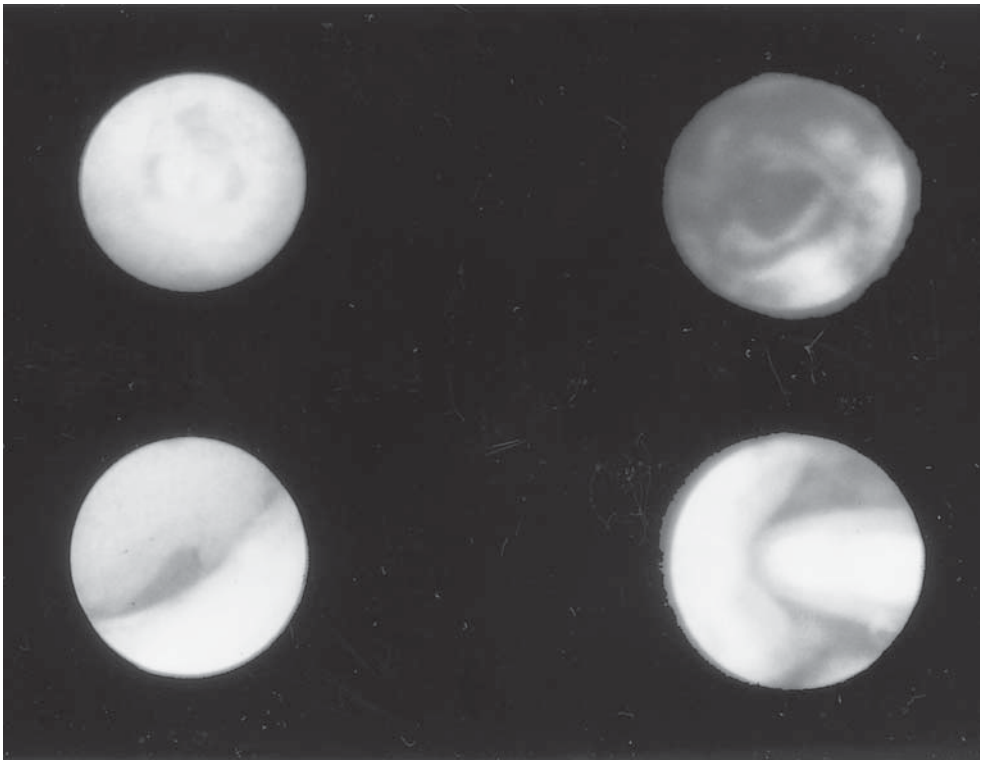

FIGURE 13.5. Endoscopic view to pathologic findings. **(A)** Adhesions of the canaliculus. **(B)** Lacrimal sac stenosis with acute inflammation. **(C)** Mucocele. **(D)** Residual silicone tube after incomplete removal.

Pediatric Endoscopy

In children under the age of 2 years, a purely diagnostic dacryoendoscopy should only be performed in exceptional cases, because the small diameter of the lacrimal passage increases the risk of injury. Diseases of the lacrimal system in newborns and infants are mainly deformational in nature and in these cases, endoscopy does not provide any essential information. Only in cases of failure after prior procedures will endoscopy with simultaneous endoscopic therapy be performed to attempt to avoid a pediatric dacryocystorhinostomy (DCR).

Minimally Invasive Procedures

The desire for lacrimal surgery without scars led to the endonasal DCR technique. Over the years, diverse modifications have been developed. The introduction of microscopes and flexible nasal endoscopes were valuable contributions to this field. The combined approach of anterograde imaging and illumination of the lacrimal system with simultaneous endoscopically controlled nasal surgery provided excellent results.[5] To minimize operative trauma, these endonasal techniques were supplemented by the use of various lasers such as Holmium, potassium titanyl phosphate (KTP), or carbon dioxide.

Laser Dacryoplasty

Holmium:YAG Laser

First attempts of a laser canaliculoplasty were performed using a holmium:YAG laser.[6] Without being linked to an endoscope, a 1-mm cross-sectional connection to the nose was created in the case of canalicular stenosis. The laser had an energy level of 100 mJ, which was delivered by a quartz fiber. After 6 months, the postoperative success rate resulted in an improvement in 57% in 17 examined.

Potassium Titanyl Phosphate Laser

The KTP laser is a very powerful solid-state laser and provides a maximum energy of 10 W, delivered by a 0.3-mm semiflexible fiber that can be connected to an endoscope. The energy released from it is sufficient for creating holes in bones.[7] This laser has been used in a small number of patients and is not frequently used at this time.

Erbium:YAG Laser

A modified, miniaturized erbium:YAG laser[3,4,8] often used for glaucoma surgery has been in use since 1996 (Figure 13.6). A 375-µm sapphire fiber delivers at most 50 mJ with 1–3 Hertz.

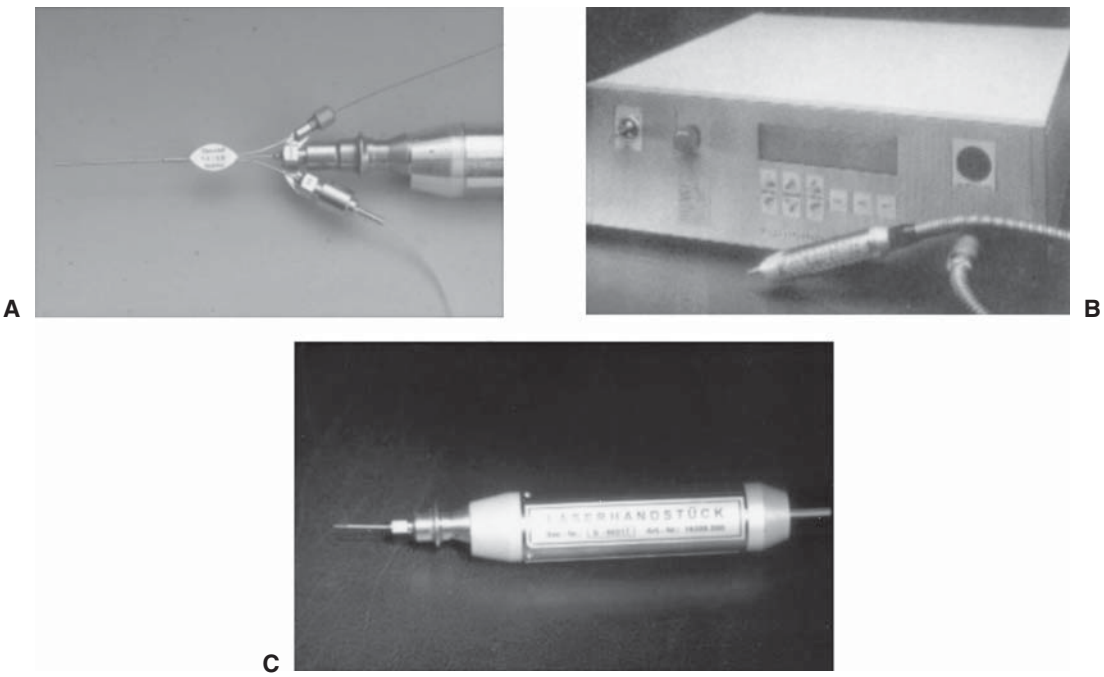

FIGURE 13.6. Erbium:YAG laser components. **(A)** Miniaturized handpiece and early version of a probe. **(B)** Erbium:YAG laser. **(C)** Canaliculus tip.

Miniaturized handpiece	**Yes**
Wavelength	**294 µm**
Energy	**Maximum 100 mJ**
Frequency	**1–3 Hertz**
Fiber length	**11 cm**
Zone of necrosis	**10–20 µm**

The erbium:YAG laser is a photoablative laser, and its maximum absorption occurs in water. Mucosal cells have a water content of 77% so ablation results quickly, but the main effect on a stenotic lacrimal passage is the resulting cavitation blister and not tissue ablation. This blister can extend over several millimeters, allowing for punctal stenoses to be opened with just a few pulses. The energy penetrates the tissue for only a few microns and its low thermal effect creates small necrosis zones of 10–20 µm, making it unsuitable for ablation of bone.

After changing the diagnostic probe from a two to a three working-channel handpiece, therapeutic interventions could be performed. Since 1996, an additional short tip of 4 cm has been developed for treating canalicular stenoses (Figure 13.6C).

Technique of Laser Dacryoplasty

Initially, a diagnostic endoscopy is performed using the same probe, Vitroptic T (Figure 13.6), before the laser application takes place. The procedure is continued until free irrigation without resistance is present and the endoscopic image confirms an opening of the mechanical stenosis. Then, bicanalicular intubation using a silicone tube is performed for preventing postoperative adhesions of the mucosa. The tube stays in place for at least 3 months. Alternatively, in cases of isolated canalicular stenosis, a monocanalicular probe can be used according to the methods of Bernard and Fayet.[9] The postoperative therapy is the same as following bicanalicular intubation in other cases.

Results of Laser Dacryoplasty

The success rate of laser dacryoplasty (LDP), judged as reduction of epiphora, is 60%–70% for all cases (n = 184). The postoperative follow-up was 20.4 months. Considering all canalicular stenoses (n = 44, follow-up more than 12 months), the success rate is 68%, and it increases to 86% for common canaliculus stenosis. These results are better when compared with those after microsurgical procedures performed without endoscopy.[8,10]

Indications for Laser Dacryoplasty

An LDP is indicated in cases of canalicular stenosis, intra- and/or postlacrimal sac lesions, and membranous occlusions after failed DCR. It has been mostly performed on canalicular and lacrimal sac stenoses with chronic infections. Unsuitable scenarios for LDP are acute dacryocystitis, mucoceles, widespread adhesions after viral infections, or stenosis caused by bone displacement after midface fractures.

Microdrill Dacryoplasty

Soon after the development of the LDP, a second technique was introduced for endoscopic transcanalicular manipulation using a microdrill, according to Busse[11] (Figure 13.7). The microdrill, connected to the Vitroptic T, consists of a stainless steel probe with a diameter of 0.3 mm, a drill driven by a shaft, and a battery-operated motor with 50 rpm. The drill is controlled by a foot pedal. After inserting the Vitroptic T into the lacrimal passage and advancing to the location of the stenosis, the drill is pulled forward under continuous irrigation. This allows the drill to be visualized throughout the procedure. After clearing the obstruction, patency is assessed by irrigation and endoscopy. The postoperative regimen (intubation and medical therapy) is the same as after LDP.

Results

The success rate of microdrill dacryoplasty (n = 168) for reduction of epiphora with the follow-up of more than 12 months is almost 78%.[10,12]

Indications

The microdrill is suitable for membranes, dacryoliths, or other mechanical obstructions, especially subtotal button-holed-style stenosis at the end of the lacrimal sac 18–20 mm distal to the punctum. The drill performs a kind of mucosal curettage; therefore, canalicular stenosis is not suitable for treatment with the microdrill system. The microdrill cannot be used to perform a DCR.

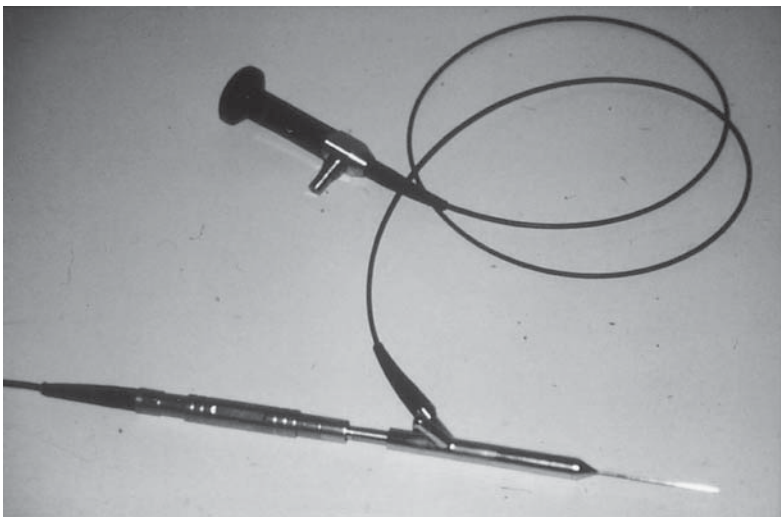

FIGURE 13.7. Microdrill and Vitroptic T.

Conclusion

Transcanalicular dacryoendoscopy combined with simultaneous minimally invasive therapy is a great step forward in diagnostic and operative choices. It has considerably reduced the rate of DCRs that would otherwise have been necessary to perform.

Transcanalicular endoscopy enables new insights into the pathology of the diseases of the lacrimal system. Today, one can directly visualize lesions and decide immediately on appropriate interventions, whereas in the past, only indirect imaging was available.

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