Treatment of Dropped Nucleus with a 27-Gauge Twin Duty Cycle Vitreous Cutter

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Key Words
Complication of cataract surgery · Dropped nucleus · Microincision vitreous surgery · 27-gauge twin duty cycle vitreous cutter · Vitrectomy

Abstract
We report herein a method for the treatment of dropped nucleus during cataract surgery with a 27-gauge twin duty cycle (TDC) vitreous cutter. When a TDC vitreous cutter is used, suction flow volume is maintained even when the cutter is driven at a high speed. This enables an Emery-Little grade 3 nucleus that had been difficult to treat with a conventional 27-gauge cutter to be successfully excised using only a vitreous cutter, with no intra- or postoperative complications. A dropped lens during cataract surgery of up to moderate hardness can be removed using a TDC cutter alone with a 27-gauge cutter system.

Introduction
One serious intraoperative complication of cataract surgery occurs if the posterior capsule is damaged during phacoemulsification of the lens and the nucleus drops into the vitreous cavity. In such cases, a vitreous cutter or fragmatome must be used to extirpate the fragments of nucleus that have dropped into the vitreous cavity [1, 2].

The popularization of microincision vitreous surgery (MIVS) has led to the use of 25-, 23-, and even 27-gauge systems for vitreous surgery that would formerly have been performed with a 20-gauge system [3]. This means that even when the nucleus drops as a complication of cataract surgery, the dropped lens is also often extirpated by MIVS [4, 5].
However, with the decrease in vitreous cutter diameter, the suction aperture in the vitreous cutters used in MIVS has also decreased, making it difficult to deal with hard fragments of nucleus that have dropped into the vitreous cavity [6]. In addition, when a vitreous cutter is used at high speed, the cutter aperture opens and the time for which suction is engaged (the duty cycle) shortens, reducing suction flow volume. This makes the efficient extirpation of dropped nucleus problematic.

The twin duty cycle (TDC) vitreous cutter developed by the Dutch Ophthalmic Research Center (DORC, Zuidland, The Netherlands) also has an aperture in the inner shaft cutting blade that opens for suction and extirpation, a design that prevents a drop in suction efficiency even when the cutter speed is increased [7].

In this study, we describe the use of a 27-gauge TDC cutter, which maintains suction power even when the vitreous cutter is driven at high speed, to deal with dropped nucleus as a complication of cataract surgery.

Materials and Methods

To treat 3 cases of dropped nucleus due to posterior capsule damage during cataract surgery (Emery-Little grade 3 in 2 cases, grade 2 in 1 case), we used a 27-gauge TDC vitreous cutter to remove the nucleus.

Patients

A 78-year-old woman underwent simultaneous vitreous and cataract surgery for proliferative diabetic retinopathy and cataract. The cataract was Emery-Little grade 3. During the cataract surgery, the posterior capsule was damaged when half the nucleus had been excised. Part of the remaining nucleus was seen to have dropped into the vitreous cavity (fig. 1a). As the original intention was to perform vitreous surgery with a 27-gauge system, an attempt was made to remove the nucleus using a 27-gauge TDC vitreous cutter.

Surgical Technique

Three ports were created using a 27-gauge transconjunctival vitreous surgery system (fig. 1a). A chandelier fiber with a xenon light source (Xenon BrightStar illumination system; DORC) was used for intraocular illumination. A 27-gauge TDC vitreous cutter was inserted via a 27-gauge cannula, and the vitreous body behind the lens and the anterior portion of the vitreous membrane were extirpated from the vitreous body side. The nucleus that remained within the capsule was then extirpated from the vitreous body side with the 27-gauge TDC cutter. The vitreous cutter settings were: cut rate, 6,000 cuts per min (cpm); suction, 600 mm Hg, and perfusion pressure, 30 mm Hg. The 27-gauge vitreous cutter was pressed against the remaining fragments of nucleus while suction was applied from the vitreous body side, cutting into and extirpating the nucleus without repelling it (fig. 1b). As portions were extirpated and size decreased, the nucleus dropped onto the retina. After the vitreous body had been removed with the vitreous cutter using the same settings, the nucleus that had dropped onto the retina was also removed. The fragments of nucleus that had dropped onto the retina were picked up from the retinal surface by suction with the vitreous cutter (fig. 1c). Extirpation of the nucleus fragments was attempted with the following cutter settings: cut rate, 6,000 cpm; suction, 600 mm Hg, and perfusion pressure, 30 mm Hg. The nucleus fragments that had been picked up by the suction power of the 27-gauge TDC vitreous cutter were retained because suction power was maintained even while the inner shaft cutting blade was being driven (fig. 1d, e), enabling efficient extirpation with the vitreous cutter (fig.
f). In this process, intraocular illumination was provided by a 27-gauge light pipe. Pieces of dropped nucleus were also successfully extirpated with the vitreous cutter while they were skewered with the 27-gauge light pipe. All dropped lens fragments were extirpated successfully with the 27-gauge TDC vitreous cutter alone, with no intraoperative complications. At the end of the operation, the trocar cannula was removed without any leakage from the scleral incision, and no suturing was required.

**Results**

To treat 3 cases of dropped nucleus due to posterior capsule damage during cataract surgery (Emery-Little grade 3 in 2 cases, grade 2 in 1 case), we used a 27-gauge TDC vitreous cutter to remove the nucleus. In all 3 cases, the nucleus that had dropped into the vitreous cavity was successfully dealt with using the 27-gauge TDC vitreous cutter alone, with no intraoperative complications. No patient required suturing because of postoperative leakage of intraocular fluid from the scleral incision, nor did any patient develop ocular hypotension or other postoperative complications.

**Discussion**

Dropped nucleus as a result of posterior capsule damage represents a serious complication that may occur during cataract surgery. In the event that the nucleus drops into the vitreous cavity, it is important to deal with the dropped lens without causing further intra- or postoperative complications. If complications arise, vitreous surgery is required. In the recently popularized MIVS, however, problems include the fact that the cutter aperture is too small to easily deal with the dropped hard nucleus, fragmatomes adapted to MIVS cannot yet be used, and intraocular fluid leaks from the extended incision when the trocar pierces the sclera during port creation, causing a drop in intraocular pressure and making it difficult to insert the trocar [6].

To avoid these problems, we have previously reported a transconjunctival vitreous surgery technique during anterior chamber irrigation, a vitreous cutter, and a light pipe through the cornea incision, with perfluorocarbon liquid to float the dropped nucleus to the surface of the iris, and using an ultrasound handpiece to emulsify and suction the fragments of nucleus while the anterior chamber is still perfused [6]. This technique does not require creation of a scleral incision, and so prevents changes in intraocular pressure during scleral port creation, as well as retinal detachment, which contributes to postoperative incarceration of the vitreous body in the scleral incision. As this method entails the insertion of surgical instruments via a corneal incision, however, fundus visibility may decline during surgery as a result of changes in the shape of the cornea.

MIVS is regarded as less invasive than the conventional 20-gauge vitreous surgery system. In particular, the 27-gauge vitreous surgery system entails little risk of incarceration of the vitreous body in the incision, and as there is almost no leakage from the incision at the conclusion of the procedure, this system is also believed to decrease the risk of complications associated with port creation [3]. The rate of postoperative intraocular fluid leakage from the incision is also extremely low and suturing is seldom required, alleviating the postoperative sensation of a foreign body in the eye felt by patients. Taking reduced fundus visibility into consideration, if dropped nucleus could be extirpated with a 27-gauge vitreous...
cutter, 27-gauge trans pars plana vitreous surgery would be safer than transcorneal vitreous surgery for dealing with a dropped lens.

Normally, a finer diameter of the vitreous cutter corresponds to a smaller suction aperture and lower suction power. As the number of revolutions per second increases, the suction aperture is also closed for longer and the duty cycle decreases. This means that the suction flow volume of a vitreous cutter declines when extirpation is being performed at a high speed [7]. Vitreous cutters use suction power to draw the vitreous body through the cutter aperture into the inner shaft of the cutter, and the inner shaft blade moves forward against the drawn-in vitreous body and extirpates it. In this process, the cutter aperture is closed by the guillotine blade of the inner shaft, causing a drop in suction power. To extirpate a nucleus with a vitreous cutter requires that a portion of the lens be drawn by suction power through the cutter aperture into the inner shaft, where it is finely shredded by the guillotine blade of the inner shaft. Normally, driving the guillotine blade at a high speed lengthens the time for which the guillotine blade of the inner shaft closes the cutter aperture, causing a drop in suction power. To deal with a moderately hard or harder nucleus requires both that suction power be maintained and that the nucleus be finely shredded, but as the suction power of conventional vitreous cutters drops when they are driven at a high speed, the nucleus is repelled from the suction aperture, and extirpation has therefore previously been carried out by running the vitreous cutter at a lower speed.

Attempts to improve the shape of vitreous cutters to maintain and improve suction power have been reported [8]. The TDC vitreous cutter reported here is designed with an aperture in the inner shaft cutting blade, which means that even when the cutting blade is driven forward and backward, the aperture in the outer shaft is not closed [7]. With conventional cutters, extirpation only occurs when the inner shaft cutting blade moves forward like a guillotine, but opening an additional aperture in the inner shaft cutting blade enables extirpation to take place when the inner shaft is driven both forward and backward. This means that the cutter can be driven at a higher speed with almost no drop in suction power, as well as enabling efficient extirpation of the vitreous body. Similarly, the 27-gauge TDC vitreous cutter is capable of extirpating a lens with a nucleus of around Emery-Little grade 3 hardness by retaining it with suction power and shredding it at a high speed. In addition, fewer postoperative complications are expected to occur when a 27-gauge vitreous system is used, meaning that fragments of dropped nucleus can be removed more efficiently and safely than with conventional cutters.

However, a nucleus of Emery-Little grade 4 hardness or harder remains difficult to resect efficiently with a 27-gauge vitreous cutter and must be floated to the surface of the iris with perfluorocarbon liquid and emulsified and suctioned with an ultrasound handpiece. Further studies are required to investigate procedures for cases of dropped nucleus harder than the present case.

**Statement of Ethics**

This study was approved by the Ethics Committee of the Jikei University School of Medicine and complied with the tenets of the Declaration of Helsinki. Informed consent was obtained from all individual participants included in the study.
Disclosure Statement

The authors declare no conflict of interest.

References


Fig. 1. a During the cataract surgery, the posterior capsule was damaged when half the nucleus had been excised. Three ports were created using a 27-gauge transconjunctival vitreous surgery system. b The 27-gauge vitreous cutter was pressed against the remaining fragments of nucleus while suction was applied from the vitreous body side, cutting into and extirpating the nucleus without repelling it. c The fragments of nucleus that had dropped onto the retina were picked up from the retinal surface by suction with the vitreous cutter. d Nucleus fragments that had been picked up by the suction power of the 27-gauge TDC vitreous cutter. e The suction power was maintained even while the inner shaft cutting blade was being driven at high speed. f A nucleus of around Emery-Little grade 3 hardness can be dealt with using a TDC cutter alone with a 27-gauge cutter system.