

Pediatric Nd:YAG laser capsulotomy in the operating room: review of 87 cases

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Abstract

• **AIM:** To report a large series of children having Nd:YAG laser capsulotomy in the operating room using the lateral decubitus position.

• **METHODS:** Medical records of children who underwent Nd:YAG laser capsulotomy in the operating room at Ann & Robert H. Lurie Children's Hospital of Chicago between September 2008 and April 2017 were reviewed. Induction of general anesthesia and intubation was performed in the supine position after which the patient was placed in lateral decubitus position. The Nd:YAG laser capsulotomy was performed using a standard protocol. At the completion of the procedure, the patient was turned back into the supine position and extubated.

• **RESULTS:** This study included 87 eyes of 60 patients. Patient's age ranged from 1 to 18y (mean 6.4±4.1y). In most cases (84/87, 97%), the procedure was performed under general anesthesia. In all cases, good focus on the membrane was achieved, and the procedure was performed successfully. There were no intraoperative ocular or anesthesia-related complications.

• **CONCLUSION:** When performing Nd:YAG laser capsulotomy in the operating room, the lateral decubitus position allows

an easy and safe approach without the risk of potentially devastating complications that have been associated with the previously described sitting and prone positions.

• **KEYWORDS:** posterior capsular opacification; YAG capsulotomy; general anesthesia; pediatric cataract

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INTRODUCTION

Posterior capsular opacification (PCO) is a common complication of cataract surgery^[1]. The incidence of PCO following pediatric cataract surgery is higher than in adults^[2-4]. In the Infant Aphakia Treatment Study (IATS), 63% of the patients in the intraocular lens (IOL) group and 12% of patients in the aphakia group needed at least one additional intraocular operation by the age of one year, and in both groups, most were performed to remove visual axis opacities^[5]. Other studies have reported the incidence of visually significant PCO after pediatric cataract surgery to be as high as 87%^[4] to 100%^[2] in young children after cataract surgery with IOL implantation without primary posterior capsulectomy. Whether a planned posterior capsulotomy and anterior vitrectomy is performed at the time of cataract surgery (typically in younger children) or left intact (usually in older children), the vast majority of pediatric cataract surgeons encounters PCO in the visual axis. Central PCO in a child requires intervention to allow the image quality needed for normal visual development and to avoid amblyopia.

The standard treatment for post-operative PCO in a cooperative adult is Neodymium-yttrium-aluminum-garnet (Nd:YAG) laser capsulotomy—a quick and painless procedure typically performed in an office setting. Since patient cooperation is paramount for successful Nd:YAG laser capsulotomy, however, the procedure may be more complicated to perform in young children, or in any patient with developmental delay. While some older children could cooperatively sit at the slit lamp, allow placement of a capsulotomy contact lens on their

eye and follow instructions, most pediatric patients may not be compliant enough to ensure adequate safety, and therefore require general anesthesia. The laser settings and technique in the operating room (OR) should be similar to an office setting. Therefore, when performing Nd:YAG capsulotomy in the OR under general anesthesia, positioning the anesthetized patient, rather than the actual act of using the laser, becomes the challenge. In 1987, Robin^[6] described performing Nd:YAG laser capsulotomy on a sedated 16 months old infant seated on the anesthesiologist's lap. Since then, several other case reports and small case series have described different methods of positioning patients. Here, we report a large series of children all having Nd:YAG laser capsulotomy performed in the OR in the lateral decubitus position.

SUBJECTS AND METHODS

Ethical Approval In this retrospective study, we reviewed the medical records of consecutive patients who underwent Nd:YAG laser capsulotomy (Lumenis Inc. San Jose, CA, USA) in the OR at Ann & Robert H. Lurie Children's Hospital of Chicago between September 2008 and April 2017. The study complied with the principles of the Declaration of Helsinki, and was approved by the Clinic Ethics Committee.

All patients underwent the procedure in the lateral decubitus position to the ipsilateral side (e.g. a right lateral decubitus to perform the procedure on the right eye; Figure 1). Preoperative pupillary dilation was achieved with cyclopentolate 1%, phenylephrine 2.5% and tropicamide 1%. In the large majority of cases, the procedure was performed under general anesthesia. The risers of the OR bed were removed so that the mattress is directly on the bed. This enables the YAG laser machine to fit under the bed and be at the right focal length for the laser to treat the lower eye. The patient was positioned in lateral decubitus, and care was taken to position all dependent bony prominences. A gel roll was placed behind the patient to secure them in place. A padded axillary roll was placed. A blanket was placed in between the patients' arms, and the lower arm was placed at the patient's side. The patient was secured to the OR bed with a safety strap and tape. The height of the YAG laser machine was put at its lowest, and the height of the OR table was elevated until the machine fits under the OR bed, almost to its highest setting. The chinrest piece of the Nd:YAG laser machine was removed (Figure 2). Because of the configuration of the laser, only the lower eye can be reached, thus positioning requires the lateral decubitus of the ipsilateral side. When the laser is correctly placed, the Helium-Neon aiming beam on standby allows the physician to determine the proper head position. All laser safety protocols were followed, including having the patient's non-operative eye covered with moist gauze, and moist towels covering the patient's face and airway.



Figure 1 Performing Nd:YAG laser capsulotomy in the OR under general anesthesia in the a right (A) and left (B) lateral decubitus position.

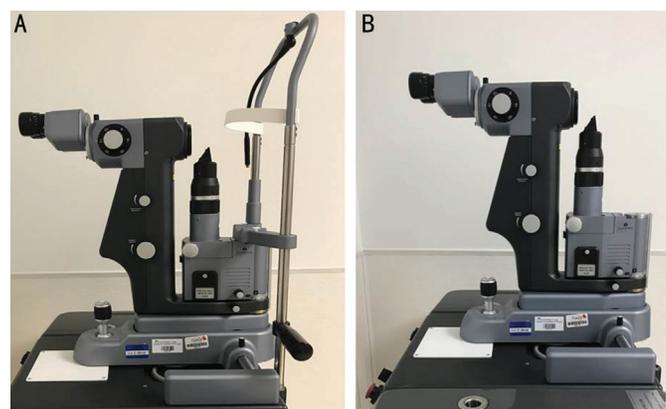


Figure 2 The Nd:YAG laser capsulotomy machine with (A) and without (B) chinrest.

The Nd:YAG laser was performed using a standard protocol with or without a contact lens, according to surgeon's preference. The aiming beam was focused on the posterior capsule and single bursts with plus (posterior) offset of 150 to 250 μ m were used typically starting at 1.0-1.4 mJ and gradually increasing if photodisruption did not occur. The procedure was complete when a satisfactory capsular opening was achieved. During the procedure, vital signs were monitored with blood pressure measurements, oxyhemoglobin saturation, and cardiac monitoring. After the completion of the laser, steroids (either topical or subconjunctival injection) and pressure lowering drops were administered. On completion of the procedure, the patients were turned back into the supine position and extubated.

RESULTS

This study included 87 eyes of 60 patients (50% females) that underwent Nd:YAG laser capsulotomy in the OR using the lateral decubitus position. In 8 cases (9%), both eyes were treated during the same OR visit. Patient's age ranged from 1y to 18y (mean 6.4 \pm 4.1y). In the vast majority of cases (85/87, 98%), patients were pseudophakic. In two cases, a posterior chamber membrane was formed in an aphakic patient. In 84/87 (97%) eyes the procedure was performed under general

Table 1 YAG capsulotomy laser parameters and results in younger vs older children

Parameter	Age<6y	Age≥6y	P
Total number of laser shots needed	99.0±7.6	109.6±9.7	0.42
Max laser energy per shot (mJ)	2.0±0.1	2.2±0.1	0.16
Total laser energy delivered (mJ)	183.5±17.5	215.3±22.3	0.30
Failure rate ^a	36%	8%	<0.01
Rate of surgical capsulectomy	3%	0	

^aFailure was defined as the need for a second YAG capsulotomy or surgical capsulectomy procedure.

anesthesia. In 3 cases (ages 7, 10 and 12y) local anesthesia with topical proparacaine was sufficient. Laser energy settings that were applied to create an opening in the posterior capsule ranged from 1.0 to 3.4 mJ, and the number of laser pulses used ranged from 18 to 304 per eye. The total amount of laser energy applied to each patient was between 36 and 703 mJ. Table 1 summarizes the different laser settings in children age 6 younger vs older children. An opening with a diameter of at least 3 mm was successfully created in all eyes. The average procedure time was 61min (range 34-99min). Procedure time was calculated as time from taking the patient from the pre-operative area to the time the patient arrived at the post anesthesia care unit (PACU). For the purpose of measuring time, only patients undergoing Nd:YAG capsulotomy as a single procedure were included. Patients that had an additional procedure scheduled (e.g. lumbar puncture, myringotomy, or exam under anesthesia) were excluded. In all cases, good focus on the membrane was achieved, the procedure was performed successfully, and there were no intraoperative ocular or anesthesia-related complications. Follow up period was 41±29mo on average. Failure rate, defined as the need for a second YAG capsulotomy or surgical capsulectomy procedure during follow up was 20% in total, mainly in younger patients (Table 1).

DISCUSSION

Nd:YAG laser capsulotomy is a relatively safe and simple procedure. It can be done in an office setting in most cases. However, young children, developmentally delayed older children, and developmentally delayed adults may be unable to sit for a Nd:YAG laser posterior capsulotomy in the clinic and, thus, require general anesthesia.

While the actual act of laser technique is similar in the clinic and in the OR, safely positioning the anesthetized patient to allow adequate focusing of the laser on the posterior capsule is crucial. In 1994, Atkinson and Hiles^[7] reported on performing Nd:YAG laser capsulotomy on 28 patients in the OR using the Microruptor III (Thun, Switzerland). This device allows a 90 degrees vertical rotation of the laser delivery system in order to perform the laser on a supine patient. While this system, in theory, would be an optimal solution, to the best of our

knowledge this instrument is not widely available. In addition, its cost-effectiveness might not justify the use^[8].

Subash and Horgan^[9] reported the use of prone position on three patients (ages 40, 20 and 14 years old). Induction of anesthesia was performed in the supine position, and following endotracheal intubation patients were turned to a prone position for the procedure and then back to the supine position for extubation and recovery. Using this technique, the torso of the patient needed to be higher than the lower limbs and the neck hyperextended in order for the chin to rest on the Nd:YAG laser slit lamp chinrest and the procedure was performed with the surgeon kneeling and the foot pedal operated by the assistant. The authors pointed out that positioning the patient prone is labor intensive and requires sufficient staffing. In addition, monitors and tubing were also temporarily disconnected if necessary. While the prone position can be used in certain clinical situations, it requires a preoperative evaluation of cardiopulmonary status, stature deformity, and vertebral column instability.

Longmuir *et al*^[10] reported performing Nd:YAG laser capsulotomy under general anesthesia in the sitting position. In this technique, after the induction of anesthesia in the supine position, the patient is positioned to the sitting position until the chin and head fit into the Nd:YAG laser delivery slit-lamp system. In addition to the surgeon, however, the scrub nurse, circulating nurse, and three additional staff persons were needed to assist in positioning the patient. Other groups have also reported on the sitting position^[11-13]; however, the sitting position under general anesthesia, especially in longer procedures, has been associated with severe complications. Transferring from a supine to a sitting position while under anesthesia can result in orthostatic hypotension. Winter *et al*^[14] pointed out that the combination of the hydrostatic gradient from the heart to the brain, the anesthesia-induced vasodilation, and decreased myocardial contractility can result in a hazardous decrease in cerebral perfusion. While this has not been reported in patients undergoing Nd:YAG laser in the sitting position, cerebral ischemia was reported in adult patients undergoing shoulder surgery in the sitting position^[15], so specific monitoring should be taken into consideration to

ensure an adequate cerebral perfusion pressure^[16]. Venous air or paradoxical-artery air embolism due to the negative intravascular pressure due to the gravitational shift of intravascular volume has also been reported^[17]. An additional serious complication is quadriplegia secondary to spinal cord compression caused by extreme neck extension^[13,17]. This is of extreme importance in patients with Down syndrome who might have atlantoaxial instability. Although rare, these complications could be devastating. Other potential risks with the sitting position include stretch injuries to the brachial plexus and to the sciatic nerves and accidental endotracheal tube extubation^[14,18].

Anecdotal reports on the use of lateral decubitus positioning for Nd:YAG laser capsulotomy under general anesthesia have been reported^[8,14]. In the last 9y, we have been performing Nd:YAG laser capsulotomy in young children and uncooperative older children using this technique, and to the best of our knowledge, this is the largest series to date reporting the outcome of this specific patient positioning. Using this approach, the risks associated with the sitting or prone positions are avoided, and there is minimum interference with monitoring or airway management. In addition, positioning the patient is simple, does not require tremendous force, and can be easily monitored by the nursing and anesthesia staff.

Lateral decubitus positioning, however, does require some modification of the commonly available Nd:YAG laser in order to accept the head of a reclining patient. Kaufman^[19] and Roseman^[20] were the first to address this mechanical challenge, and suggested replacement of the regular head rest with a rectangular frame to support the head of the reclining patient during the laser treatment. We found that simply removing the chin rest of the laser machine allows adequate approximation and focusing on the posterior capsule. An additional logistical consideration we encountered is that when using lateral decubitus positioning, the OR bed typically needed to be raised to its maximum height in order to place the Nd:YAG laser underneath. In this situation the OR bed would be four feet off the floor and the use of safety straps are highly recommended.

Although our group typically performs Nd:YAG capsulotomy in children and uncooperative adults under general anesthesia, we do consider topical anesthesia if the patient seems cooperative and have performed Nd:YAG laser capsulotomy on these patients in an office setting (unpublished data). Cinal *et al*^[12] reported on performing Nd:YAG laser capsulotomy in a sitting position in an office setting with or without topical anesthesia. In their report, the average age was 8.81y with the youngest patient being 3 years old. In the current series, a 12-year-old female was cooperative enough in the OR, and the procedure was successfully performed with her being awake.

While this approach could be beneficial in selected children, our experience shows that in most cases, especially in younger children, general anesthesia is required for a safe procedure, and the ophthalmologist should be prepared to perform Nd:YAG laser in the OR. In our series the average operative time was 61min but this included transit time moving between the preoperative area, OR, and the recovery room. Therefore, this would be an overestimate of total anesthetic time or procedural time. In addition, some patients underwent bilateral Nd:YAG laser capsulotomy so the duration would be longer to include repositioning and two procedures.

In summary, when performing Nd:YAG laser capsulotomy in the OR, we feel that the lateral decubitus position may facilitate an easy and safe procedure. However, a direct comparison between the different positioning methods is still lacking, but using the lateral decubitus position eliminates the risk of potentially devastating complications. Turning the patient from a supine to lateral decubitus position can be easily achieved without the need for additional staff members or special preoperative evaluation. In our series of 87 cases there were no ocular or anesthesia related complications.

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