ORIGINAL ARTICLE/KLİNİK ÇALIŞMA

Endoscopic Laser Cyclophotocoagulation Treatment in Various Types of Glaucoma in Aphakic and Pseudophakic Eyes

Afakik ve Psödofakik Gözlerdeki Çeşitli Glokom Tiplerinde Endoskopik Lazer Siklofotokoagülasyon Tedavisi

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ABSTARCT

Purpose: Our aim was to evaluate the efficacy and safety of endoscopic laser cyclophotocoagulation (ECP) in aphakic and pseudophakic glaucoma patients.

Materials and Methods: This retrospective case series comprised 53 eyes of 52 patients (36 males, 16 females) who underwent ECP. The types of glaucoma in the patients were as follows: primary open angle glaucoma (21 eyes, 39%), pseudoexfoliative glaucoma (10 eyes, 19%), secondary congenital glaucoma (6 eyes, 11%), neovascular glaucoma (5 eyes, 9%), glaucoma after pars plana vitrectomy (4 eyes, 8%), glaucoma after keratoplasty (3 eyes, 6%), glaucoma after blunt trauma to the eye (2 eyes, 4%) and glaucoma due to Sturge-Weber Syndrome (2 eyes, 4%).

Results: Patients' ages ranged from 3 to 80 years (mean age was 59.1±21.4 years). Mean follow-up time was 12.0 months (SD: 5,2). Mean preoperative intraocular pressure (IOP) was 24.6 (SD: 7.8) mmHg, and mean postoperative IOP at the last visit was 16.5 (SD: 5.1) mmHg ($p<0.001$). The average number of anti-glaucoma medications used by the patients decreased from 2.87 (SD: 0.98) to 2.13 (SD:1,26), ($p<0.001$). The success rate of the treatment was 83%.

Conclusions: ECP is a safe, effective, and repeatable procedure in aphakic and pseudophakic glaucoma patients. Its main advantage is in giving surgeons the opportunity to see ciliary bodies while photocoagulating them.

Key Words: Endoscopic laser cyclophotocoagulation, glaucoma, intraocular pressure.

ÖZ

Amaç: Bu çalışmadaki amaç, afak veya psödofakik glokomlu hastalarda uyguladığımız endoskopik lazer siklofotokoagülasyon tekniğinin etkinliğini ve güvenliğini değerlendirmektir.

Gereç ve Yöntem: ESF uygulanan 52 hastanın (36 erkek, 16 kadın) 53 gözü retrospektif olarak incelendi. Daha önce başka metodla siklodestrüksiyon uygulanan hastalar çalışmaya alınmadı. Çalışmaya alınan hastalardaki glokom tipleri; primer açık açılı glokom (21 göz-%39), psödoeksfoliatif glokom (10 göz-%19), sekonder konjenital glokom (6 göz-%11), neovasküler glokom (5 göz-%9), pars plana vitrektomi sonrası glokom (4 göz-%8), keratoplasti sonrası glokom (3 göz-%6), künt travma sonrası glokom (2 göz-%4) ve Sturge Weber Sendromuna bağlı glokom (2 göz-%4) şeklindeydi.

Bulgular: Hastaların ortalama yaşı 59.1 yıl (SD:21.4) (3-80 yaş), ortalama takip süresi ise 12.0 aydı (SD:5.2). Hastaların pre-operatif ortalama göz içi basıncı (GİB) değeri 24.6 (SD:7.8) mmHg iken post-operatif son kontrolde bu değer 16.5 (SD:5,1) mmHg olarak saptanmıştı ($p<0.001$). Hastaların pre-operatif kullandıkları antiglokomatöz ilaç adedi ortalama olarak 2.87 (SD:0.98) iken post-operatif son kontrollerindeki ortalama ilaç adedi ise 2,13 (SD:1.26) olarak saptandı ($p<0.001$). Tedavinin başarı oranı %83 olarak tespit edildi.

Sonuç: ESF, afak ve psödofakik glokomlu hastalarda etkili, güvenilir ve tekrarlanabilir bir yöntemdir. En büyük avantajı, siliyer cisimleri görerek tedavi etme şansı sağlamasıdır.

Anahtar Kelimeler: Endoskopik lazer siklofotokoagülasyon, glokom, göz içi basıncı.

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INTRODUCTION

For many years, cyclodestructive procedures have been used to treat glaucoma with the aim of decreasing aqueous humor production by destroying the ciliary processes.[1-4] These procedures were usually performed via a transscleral route, either by freezing the ciliary body (cyclocryotherapy) or by coagulating the ciliary body with a laser source. With the exclusion of endoscopic laser cyclophotocoagulation (ECP), because the surgeon is not able to see the areas being treated, adjacent tissues may be damaged during this process, which may lead to a relatively high rate of complications such as pain, visual acuity reduction, inflammation, hypotony, and phthisis bulbi. A relatively new method called ECP gives us the chance to see the target treatment areas exactly, which increases the safety and efficacy of this procedure. ECP has the unique capability of simultaneous visualization and treatment of the ciliary body through a pars plana or limbal approach, even combined with a cataract extraction.[5] ECP is particularly easy and well suited to lower intraocular pressure and reduces the need for glaucoma medications.[5] Although it is more suitable to do the operations on aphakic and pseudophakic eyes, it is possible to operate on phakic eyes by using a viscoelastic substance to create space between the patient's iris and lens.[6] Although ECP was initially used for refractory glaucomas where intraocular pressure remained elevated after all other medical and surgical interventions, nowadays it is used for most glaucoma types, including neovascular glaucoma and pediatric glaucoma. It is also used to diminish the need for topical medications even if the glaucoma progression is not rapid.[5-7]

This study provides intermediate follow-up times and is confined to only aphakic and pseudophakic eyes. Different from previous reports, we investigated the effects of using anterior chamber maintainer (ACM) vs viscoelastic substance (VES) during ECP in the aspects of treatment effectivity and post-operative complications. Our aim is to report on the safety and efficacy of our early experiences with this relatively new surgical procedure.

MATERIALS AND METHODS

This retrospective study comprised 53 eyes of 52 patients (36 males, 16 females) who underwent ECP and followed up between June 2007 and January 2011. This study followed the tenets of the Declaration of Helsinki and informed consent was taken from all the patients.

Study Population: All the patients had at least six months of follow-up and maximum follow-up was up to 18 months. Patients who previously underwent other methods of cyclophotocoagulation treatment did not take part in this study. But previous laser trabeculoplasty or trabeculectomy was not a reason for exclusion.

The types of glaucoma in the patients were as follows: primary open angle glaucoma (21 eyes, 39%), pseudoexfoliative glaucoma (10 eyes, 19%), secondary congenital glaucoma (6 eyes, 11%), neovascular glaucoma (5 eyes, 9%), glaucoma after keratoplasty (3 eyes, 6%), glaucoma after pars plana vitrectomy (4 eyes, 8%), glaucoma after blunt trauma to the eye (2 eyes, 4%), and glaucoma due to Sturge-Weber Syndrome (2 eyes, 4%). The decision to perform the ECP operation was made after having followed patients for some time in our glaucoma clinic.

Measurement Techniques: Other than two pediatric patients whose IOP values were measured with the Schiotz tonometer, all IOP measurements were done with the Goldmann applanation tonometer (GAT). All IOP measurements were done under the same biomicroscope and GAT, except for postoperative first day. IOP measurements were done in the morning hours to take into account the circadian IOP variations.

Surgical Techniques: Combined phacoemulsification and ECP was done in 31 eyes, and the other 22 eyes underwent ECP only. During the ECP procedure, anterior chamber maintainer (ACM) was used in 36 eyes and viscoelastic substance (VES) was used in 17 eyes. Sodium hyaluronate 3% was used as VES. In 26 eyes, 180°-270° ciliary body ablation was done, and in 27 eyes 270°-360° ablation was done. The decision of treatment area was done arbitrary, but pre-operative IOP values might have generated bias on treatment area. In 12 eyes, 100 mW energy was used, and 200 mW was used in 25 eyes, 300 mW in 12 eyes, and 400 mW in 4 eyes. Treatment energy decision was given according to the shrinkage status of the ciliary processes.All the operations were done by two experienced surgeons (SB, EB). All the operations were done with the same phacoemulsification machine (Alcon Infinity, Alcon Laboratories, Inc, Fort Worth, Texas, US) and ECP machine (Endo Optiks E2 system, 2 watt 810 nm diode laser, Little Silver, New Jersey, US). Adult patients were operated on under local anesthesia (subtenon), and pediatric patients were operated on under general anesthesia. The cataract operations were uneventful. All the operations were done by creating limbal incisions (the pars plana method was not used). Two limbal incisions were created for the patients receiving 270°-360° ECP, and one incision was created for the patients receiving 180°-270° ECP. By the help of VES or ACM, the ECP probe (20 gauge) was inserted into the posterior chamber and the laser was applied at an appropriate distance to the ciliary bodies (2 mm). Laser photocoagulation was applied to the anterior parts of the ciliary bodies.

Treatment time was adjusted to continuous mode. Shrinkage and whitening of the ciliary bodies were our aim in the operations. Laser power and/or duration were decreased if a "pop" was heard. In combined phacoemulsification and ECP operations, the ECP procedure was done after aspiration of the cortex material and before implantation of the intraocular lens. Topical antibiotics and corticosteroids were prescribed postoperatively and tapered as the intraocular inflammation decreased. Postoperatively patients were examined at first day, first week, first month, third month, and every three months thereafter. Failure of treatment was defined as an IOP greater than 21 mmHg or greater than the preoperative values during two consecutive postoperative visits; IOP below 6 mmHg for 30 days or more (hypotony); eyes that required another surgical intervention due to uncontrolled IOP; and eyes that needed more topical antiglaucoma medications after the operation.

Statistical Analysis: For the statistical analysis, SPSS 17.0 for Windows (SPSS Inc., Chicago, IL, USA) was used. Paired samples t-test was used to compare mean pre-operative and post operative IOP and number of antiglaucoma medications. Mean IOP decrease values of different ECP techniques were compared by using independent samples t-test. Chi-square test was used to analyze the relation between post-operative complications and different ECP techniques. Also, the life table analysis was used to show overall success. P <0.05 was accepted as statistically significant.

RESULTS

The patients' ages were ranged from 3 years to 80 years (mean age was 59.1±21.4 years). Mean follow-up time was 12.0 months (SD: 5.2). Mean preoperative intraocular pressure (IOP) was 24.6 (SD: 7.8) mmHg, and mean postoperative IOP at the last visit was 16.5 (SD: 5.1) mmHg (p<0.001). The average number of antiglaucoma medications decreased from 2.87±0.98 to 2.13±1.26 (p<0.001) at the last visit.

The success rate of the treatment was 83%. Success rates according to glaucoma types were as follows: Glaucoma after keratoplasty, 100%; glaucoma after blunt trauma, 100%; primary open angle glaucoma, 95%; PSX glaucoma, 90%; neovascular glaucoma, 80%; glaucoma after PPV, 75%; Sturge-Weber Syndrome glaucoma, 50%; and glaucoma after congenital cataract operation, 33%. In only ECP group, in only one patient (5%) we detected BCVA decrease and in 21 eyes (95%) BCVA remained the same at the last visit. In combined phacoemulsification and ECP group, we detected BCVA increase in 21 eyes (68%), BCVA decrease in only one eye (3%) and BCVA stability in 9 eyes (29%). In the ECP-only group, the mean preoperative IOP value was 27.6 mmHg (SD: 8.7), and mean postoperative IOP value was 18.2 mmHg (SD: 7.3) at the last visit. In the combined phacoemulsification and ECP group, mean preoperative IOP value was 22.5 mmHg (SD: 6.4) and mean postoperative IOP value was 15.5 mmHg (SD: 3.7). There was no statistical difference in IOP decrease ability between these two techniques (p=0.72). Comparison of average intraocular pressure decrease effects of combined phacoemulsification-ECP procedure and only ECP is shown in table 1. In the eyes in which anterior chamber maintainer (ACM) was used during ECP (n=36), mean preoperative IOP value was 24.5 (SD: 8.2) mmHg, and mean postoperative IOP value was 16.1 (SD: 4.5) mmHg at the last visit. In the eyes in which viscoelastic substance (VES) was used during ECP (n=17), mean preoperative IOP value was 24.9 (SD: 7.2) mmHg, and mean postoperative IOP value was 17.8 (SD: 7.4) mmHg.

There was no statistical difference in IOP decrease ability between these two techniques (p=0.49). Comparison of average intraocular pressure decrease effects of ACM and VES techniques was shown in table 2. Postoperative IOP increase in the first day was detected in 7 eyes. These were 4 of 36 eyes (11%) that received ECP with ACM technique and 3 of 17 eyes (18%) that received ECP with VES technique (p<0.001).

Table 1: *Comparison of average intraocular pressure decrease effects of combined phacoemulsification + ECP procedure and only ECP.*

Follow-up time	ECP only (mmHg)	ECP+Phaco (mmHg)	P value
Day 1	7.8±11.3	3.4±8.5	0.11
Week 1	8.8±10.7	6.1±8.6	0.32
Month 1	6.0±11.2	7.4±8.6	0.62
Month 3	4.4±11.8	7.0±7.3	0.31
Month 6	7.9±8.5	7.2±7.7	0.77
Month 9	11.1±9.0	7.3±6.0	0.15
Month 12	9.6±8.5	5.7±6.3	0.16
Month 15	9.8±9.3	7.4±6.2	0.48
Month 18	7.6±7.5	6.8±4.6	0.79

ECP; Endoscopic Laser Cyclophotocoagulation, Phaco; Phacoemulsification.

Table 2: *Comparison of average intraocular pressure decrease effects of anterior chamber maintainer (ACM) method and viscoelastic substance (VES) method.*

Follow up time	ACM (mmHg)	VES (mmHg)	P value
Day 1	6.4±10.1	3.4±9.0	0.28
Week 1	8.0±9.2	6.9±10.6	0.71
Month 1	8.0±10.5	6.3±8.1	0.52
Month 3	6.6±11.2	6.3±5.0	0.88
Month 6	8.8±8.9	6.5±6.4	0.40
Month 9	8.8±8.1	8.5±5.8	0.90
Month 12	8.1±8.3	5.7±5.1	0.48
Month 15	9.9±7.5	6.1±4.9	0.24
Month 18	8.4±7.5	6.0±4.5	0.37

ACM; Anterior Chamber Maintainer, VES; Viscoelastic Substance.

Ten of the total 13 eyes (10 of 36 ACM-applied eyes: 28%) in which we detected postoperative fibrin reaction in the anterior chamber were in the ACM group, and the other 3 eyes (3 of 17 VES-applied eyes: 18%) were in the VES group (p<0.001). In the eyes that received 180°-270° ECP, mean preoperative IOP value was 22.4 (SD: 6.9) mmHg, and mean postoperative IOP value at the last visit was 16.5 (SD: 4.6) mmHg. In the eyes that received 270°-360° ECP, mean preoperative IOP value was 26.1 (SD: 8.7) mmHg, and mean postoperative IOP value at the last visit was 16.4 (SD: 5.7) mmHg. The statistical difference between the ability of these two techniques in terms of IOP decrease was not significant (p=0.078). Comparison of average intraocular pressure decrease effects of treatment area amounts (180°-270° and 270°-360°) was shown in table 3. Overall pre-operative medication number decreased from 2.87±0.98 to 2.13±1.26 (p<0.001) at the last visit. The effects of different ECP techniques on amount of topical medication usage are shown in table 4. The life table analysis (survival curve) for the overall patients was shown in graphic. When postoperative complications were evaluated according to ECP energy amounts, 12 eyes underwent 100 mW energy (fibrin reaction in 3 eyes, transient IOP rise in one eye, and transient hypotonia in one eye); 25 eyes underwent 200 mW energy (fibrin reaction in 4 eyes, transient IOP rise in 5 eyes, and transient hypotonia in one eye); 12 eyes underwent 300 mW energy (fibrin reaction in 6 eyes, transient IOP rise in one eye); and 4 eyes underwent 400 mW energy (no complications). Re-ECP was applied in 4 patients in whom the target IOP values were not reached after the first ECP operations. The success rate of re-ECP operations was 75%, and we did not encounter any intra- or postoperative complications in these cases. In none of the patients did we encounter intra-operative complications (hyphema, IOL dislocation, corneal oedema, vitreus hemorrhage, etc.). Overall postoperative complications were fibrin reaction in the anterior chamber (25%), transient IOP increase (13%), and transient hypotonia (4%) in the first days postoperatively.

DISCUSSION

Cyclodestructive procedures are usually applied in cases of glaucoma that are refractory to medical and surgical therapy, and in eyes that have little or no visual potential. However, ECP, which is a combination of both surgical and laser treatment, can be used in most types of glaucoma including refractory glaucomas, although it is a cyclodestructive procedure.

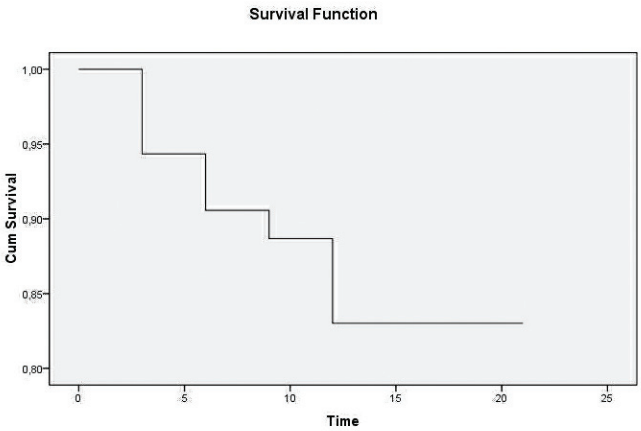
Table 3: *Comparison of average intraocular pressure decrease effects of treatment area amounts (180°-270° and 270°-360°).*

Follow up time	180-270 degrees (mmHg)	270-360 degrees (mmHg)	P value
Day 1	3.4±8.5	7.7±10.8	0.11
Week 1	5.8±8.7	9.6±10.3	0.14
Month 1	6.3±8.8	8.8±10.8	0.35
Month 3	5.0±8.1	8.3±11.0	0.21
Month 6	5.9±7.4	10.2±8.7	0.07
Month 9	7.1±5.2	10.1±8.9	0.25
Month 12	5.1±4.7	9.5±9.1	0.11
Month 15	7.3±5.4	11.6±9.4	0.26
Month 18	7.1±5.4	9.7±8.7	0.49

Table 4: The effect of different ECP techniques on amount of topical medication usage is shown.

Technique	Pre-op. medic. #	Post-op. medic. #	P value
ECP only	3.2±0.9	2.4±1.3	0.005
ECP+Phaco	2.6±1.0	2.0±1.2	0.002
ACM	3.0±0.8	2.1±1.2	<0.001
VES	2.7±1.3	2.2±1.3	0.04
180°-270°	2.7±1.0	2.0±1.2	0.004
270°-360°	3.0±0.9	2.3±1.3	0.003

ECP; Endoscopic Laser Cyclophotocoagulation, Phaco.; Phacoemulsification, op.; operation, medic.; medication, #; number, °;degree (treatment area amount), ACM; Anterior Chamber Maintainer, VES; Viscoelastic Substance.



***Graphic:** The life table analysis (survival curve) for the overall patients was shown (time: months).*

In our study, mean preoperative intraocular pressure (IOP) was 24.6 mmHg and mean postoperative IOP at the last visit was 16.5 mmHg (p<0.001). As seen from these results, we think that ECP is very effective in decreasing IOP in the intermediate follow-up periods. Lima et al. reported that in their study including 539 cases, a decrease in IOP values from 38.1 mmHg to 12.1 mmHg occurred after ECP.[8] Murthy et al. detected a decrease of IOP values from 32.6 mmHg to 13.9 mmHg in their study including 50 glaucoma patients.[9] In these two studies, the researchers achieved a greater IOP decrease than we did. Carter et al.,[7] reported that mean preoperative 32.6 mmHg IOP value decreased to 22.9 mmHg postoperatively at the last visit, in their study including 25 aphakic and pseudophakic pediatric glaucoma patients. They also reported that average ECP operation number per eye was 1.5 and overall success rate was 53%. In our study we had only 6 pediatric patients and our success rate, 33%, was the lowest in this group. In this study, the success rates of primary open angle glaucoma (n=21) and pseudoexfoliation (PSX) glaucoma (n=10) were very high, 95% and 90%, respectively. In neovascular glaucoma (NVG) cases (n=5), we reached the target IOP postoperatively in 4 of 5 cases (80%). Although Murthy et al. reported 25% postoperative hypotonia in NVG, we did not encounter hypotonia in these 5 cases.[9]

Uram, the first surgeon to apply ECP, in his first study with ECP achieved 28.3% decrease in IOP values in 10 NVG patients.[10] It is very convenient, safe, and effective to combine ECP with phacoemulsification if the patient has a cataract. In addition to the IOP decrease effect of cataract surgery, ECP also decreases the IOP and a dual effect occurs.[11,12] But, in our study we did not find statistically important additional IOP decreases in combined procedures when compared with ECP only.

Netland et al.,[13] reported a case that underwent combined phacoemulsification and ECP procedure and in whom a refractory IOP rise above 50 mmHg occurred. They thought this IOP rise might be due to residual VES, residual cortical material, effects of postoperative topical steroid drops, possible angle closure, or malign glaucoma.[13] As the number of topical anti-glaucoma medications increases, the quality of life and the compliance of the patients to the therapy decrease; therefore, one of the aims of glaucoma surgery must be to focus on this situation. In this study, the average number of antiglaucoma medications decreased from 2.87 to 2.13 (p<0.001) following ECP procedure. Lima found this decrease to be from 3.9 to 1.9 topical medications, and Murthy found this decrease in medication numbers to be from 2.51 to 1.09.[8,9] Yu et al.,[14] suggested that if the distance between the laser probe and the target ciliary body is 2 mm, the effectiveness of the procedure will be at its optimum.

Berke suggested treating at least 200 degrees for every case and treating the entire ciliary process from top to bottom, as well as the space between processes.[5] In our cases, we did not apply the laser to the space between processes, but tried to adjust the 2 mm distance between the laser probe and the target ciliary body in all our cases.

The ECP procedure may be applied with the help of both VES and ACM. In our study we compared these two techniques and found that the IOP decrease rate with them was similar in each one but different in terms of postoperative complications. We detected more fibrin reaction in the ACM group and more first-day IOP rise in the VES group.

Less fibrin reaction in the VES group might be due to prevention of the distribution of inflammatory mediators all around the anterior and posterior chamber by a physical blockade effect of VES. More first-day IOP rise in the VES group was probably due to residual VES. Kahook et al.,[15] reported that by creating two different incisions compared to a single incision for the laser probe, it is possible to treat larger areas of ciliary body, increasing the effectiveness of the procedure. Also in this study, although the difference is not statistically important, we noticed more IOP decrease as the treatment area increases.

We tried to apply the minimum energy required for ablation in order to decrease intra-and postoperative complications. But we did not find an important difference in the aspect of complications between delivered energy amounts in the ranges of 100 mW to 400 mW. It is also safe and effective to apply re-ECP. We performed re-ECP in four cases and in three of those, target IOP values were reached (75% success). We did not encounter any complications in re-ECP cases. It is also suitable to combine some other surgical procedures like pars plana vitrectomy and keratoplasty with ECP, although the most effective combination seems to be with phacoemulsification.[9,16] Pantcheva et al.,[17] deduced that in ECP procedure when compared with transscleral cyclophotocoagulation, there is less tissue damage and less structural deformation. They reported that sclera and ciliary muscle were not damaged in ECP, while the ciliary epithelium, which must be the main target, receives the most damage. The effect of ECP among different races may be different. Yip et al.,[18] compared the effects of ECP among races and found that the success rate appears poorer in Asian patients when compared with Caucasian populations. They also noted that the treatment effect appeared to wane between 18 and 24 months post-treatment.[18] In their study about timing of ECP, Huang and Lin reported that by the indication of recent studies, ECP might be a reasonable first-line surgery or even first-line treatment.[19] There are some restrictions of this study. The non-standardization of inclusion criteria is a major weakness.

Since the number of entities is so large and the sample size for each entity is small, it is difficult to make some definitive recommendations. Also, treatment decisions regarding whether cataract surgery was performed at the time of ECP and the extent of ECP treatment were based on clinical judgment somewhat. In conclusion, ECP is a safe, effective, and repeatable procedure in aphakic and pseudophakic glaucoma patients. Its main advantage over other methods is that it allows the surgeon to see the ciliary bodies while treating them, which is especially important in pediatric aphakic eyes and pseudophakic eyes where the location of the ciliary bodies are changed somewhat.[20] Its main disadvantage is that as a basic concept, ECP is a destructive surgery against normal ocular function. Some other disadvantages are orientation problem for surgeons new to endoscope and limitations of imaging such as lack of stereopsis.

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