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Infusion cannula-associated jet stream effects on vitrectomy results

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Abstract

Aim: To show infusion cannula-associated jet stream effects on the posterior pole of the retina during vitrectomy.

Materials and Methods: For this retrospective study 39 eyes of thirty-nine patients were assigned to the two groupsregarding their infusion cannula position during vitrectomy. Group 1 consisted of the patients who had a cannula placed at an angle to the sclera and also there was a two-step entering position of the trocar. Group 2 consisted of the patients who had a cannula that was fixated perpendicular to the sclera. The results of preoperative and postoperative examination of the patients were evaluated.

Results: There were 20 patients in group 1 and 19 patients in the group 2. There was no significant difference between the groups regarding preoperative visual acuity (1.79±0.77 logMar for the group 1 and 1.86±0.59 logMar for the group 2, p= 0.989). The differences in thepreoperative intraocular pressures (IOPs) were not statistically significant between the groups (13.3±2.9 mmHg for the group 1 and 13.1±2 mmHg for the group 2, p= 0.460). The mean duration of surgery in group 1 was 48±12 minutes and was 50±10 minutes for the group 2 (p= 0.460). The postoperative visual acuity was 0.24±0.21 logMar in group 1 and 0.53±0.28 logMar in group 2. There was statistically significant difference between the groups regarding the postoperative visual acuity (p= 0.0001). The difference of postoperative IOPs were comparable among the groups (14.9±4.2 mmHg for the group 1 and 13.4±2.8 mmHg for the group 2, p= 0.289).

Conclusion: The present study shows infusion cannula associated jet stream may reduce postoperative visual acuity. Using new type of design for infusion cannulas or method for placing the infusion cannula in an angle to avoid the flow force on posterior pole should be considered for better vitrectomy results.

Introduction

Vitreoretinal surgery results have improved due to latest improvements especially by using smaller instruments. Nevertheless the results are still limited by various challenges that currently exist [1,2]. One of these unresolved problems is the jet streamfrom infusion cannula. Fluid flow from infusion cannula creates jet stream that has a water cannon effect on the retina [3]. Some of the studies have claimed postoperative visual field defects due to infusion in vitrectomized eyes [4-6]. The smaller diameter of cannula may cause a stronger jet stream through fluid flow. There are some reports regarding injuries on the retina associated with the jet stream associated injuries. Most of them described iatrogenik retinal breaks (IRBs) opposite to the infusion cannula and were associated with the jet stream. Bilgin et al. reported 3 cases of IRBs that were directly associated with the infusion jet stream and these had been attributed to the fluid-air exchange step [7]. Belenje et al. reported one similar case with the same mechanism [8]. In these reports the authors outlined the importance of flow cannon effect on retina opposite to the infusion cannula, and vitrectomy devices that had intraocular pressure control (IPC) systems were blamed [7,9]. These types of injuries can result in retinal detachment and various other conditions. Continuous jet stream from infusion cannula may affect the posterior pole. Our knowledge and also the studies regarding this clinical entity are insufficient to reach a solid clinical judgement. We hypothesize that the jet stream may cause invisible damage to the macula and optic nerve head, and therefore diminish visual quality of the patients. Our aim in the present study was to investigate and compared the results of two different infusion cannula position in vitrectomy surgeries.

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Materials and Methods

This retrospective study was designed and conducted at a tersiyer ophthalmology clinic. We strictly adhered to the ethical principles of Helsinki declaration throughout all stages of our study. Local Ethical committee approved the study (Inonu University Health Sciences Non-Interventional Clinical Research Ethics Committee, Decision number: 2024/6681). Informed consent was obtained from all the participants. Preoperative, intraoperative and postoperative clinical variables of the patients were obtained from the hospital records. Personal information of the patients was kept confidential. The patients who received vitreoretinal surgery for retinal detachments (24 cases), vitreous hemorhage (10 cases), dropped nucleus or intraocular lens (4 cases), and floaters (1 case) were included the study. The patients who had any membrane peeling procedures were excluded from the study. The patients were assigned to two groups according to the type of intraoperative infusion cannula placement. Group 1 consisted of patients who had a cannula was placed with an angle to sclera and had a two step procedure for inserting the trocar (Figure 1). Group 2 consisted of patients who had a cannula that was fixed perpendicular to the sclera with sticky drape (Figure 2). All surgeries were completed with the same 23 gauge vitrectomy device EVA™ (Dutch Ophthalmic Research Center, DORC), Zuidland, The Netherlands). The device settings were the same for all patients. All surgeries were performed by the same surgeon (NP). Pre- and postoperative visual acuity (VA), intaocular pressure (IOP), duration of surgery, development of intraoperative rebound hypotonia, intraoperative iatrogenic posterior lens capsule trauma, postoperative cataract, postoperative epiretinal membrane (ERM), and postoperative macular edema were evaluated. The primary output/endpoint variable was visual acuity. The visual acuities were converted to the logMar for statistical analaysis. Postoperative examination results were gathered 3 months following the surgeries. If silicone oil was used for tamponade, the study parameterswere gathered 3 months after the tamponade extraction procedure.

Statistical analysis

The data were evaluated with SPSS 22.0 (IBM Corporation, Somers, NY, USA) software. The continuous variables were expressed as mean±SD. The categoric variables were expressed as he number affected individuals and the percentage of the study population. The Shapiro-wilk test was used as the normality test. The categorical variables were compared using the Chi-Square and Fisher's exact tests, while the Mann–Whitney U test was used for the comparison of the continuous. A p value less than 0.05 was accepted as a statistically significant difference among the study groups.

Results

There were 20 patients in Group 1 and 19 patients in Group 2. The mean age of the patients in Group 1 was 57.75±12.83 (15-78) years and was 63.50±13 (33-83) years in Group 2 (p= 0.201). There were no significant difference between the groups in terms of preoperative VA (1.79±0.77 logMar for the group 1 and 1.86±0.59 logMar for the group 2, p= 0.989). The difference of preoperative IOPs were not statistically signficant among the groups (13.3±2.9 mmHg for Group 1 and 13.1±2 mmHg for Group 2, p= 0.460). The mean duration of surgery for Group 1 was 48±12 minutes and 50±10 minutes for Group 2 (p= 0.460). Intraoperative rebound hypotonia events were observed in 10 patients in Group 1 and none in Group 2 (p= 0.0001). The lens was intraoperatively damaged by the infusion cannula in 3 patients in Group 1. On the other hand, intraoperative damage to the lens was not observed in none of the patients in Group 2 (p= 0.231).The postoperative VA was 0.24±0.21 logMar in Group 1 and 0.53±0.28 logMar in Group 2. There was a statistically significant difference between the groups in terms of postoperative VA (p= 0.0001). There was no significant difference in postoperative IOPs among the groups (14.9±4.2 mmHg in Group 1 and 13.4±2.8 mmHg in Group 2, p= 0.289) (Table 1). Six patients in Group 1 and 5 patients in

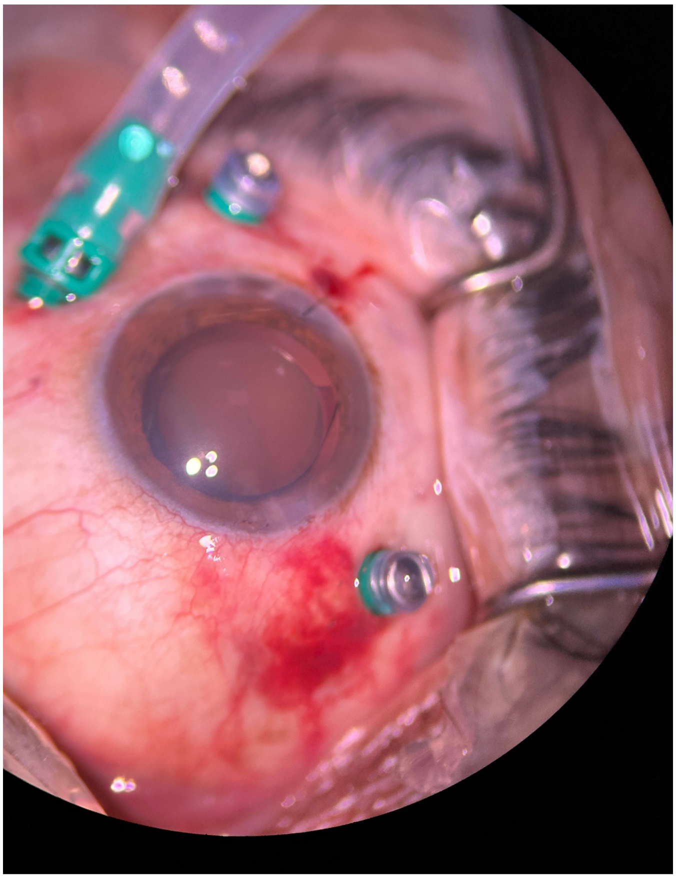

Figure 1. Angled placement of the infusion cannula.

Table 1. Comparison of the data of the study groups.

	Group 1	Group 2	P
Preoperative VA (logMar)	1.79±0.77	1.86±0.59	0.989
Postoperative VA (logMar)	0.24±0.21	0.53±0.28	0.0001*
PreoperativeTo (mmHg)	13.3±2.9	13.1±2	0.460
PostoperativeTo (mmHg)	14.9±4.2	13.4±2.8	0.289
Duration of surgery (mins)	48±12	50±10	0.460

VA: Best corrected visual acuity, To: intraocular pressure measured with applanation tonometry, * Statistically significant.

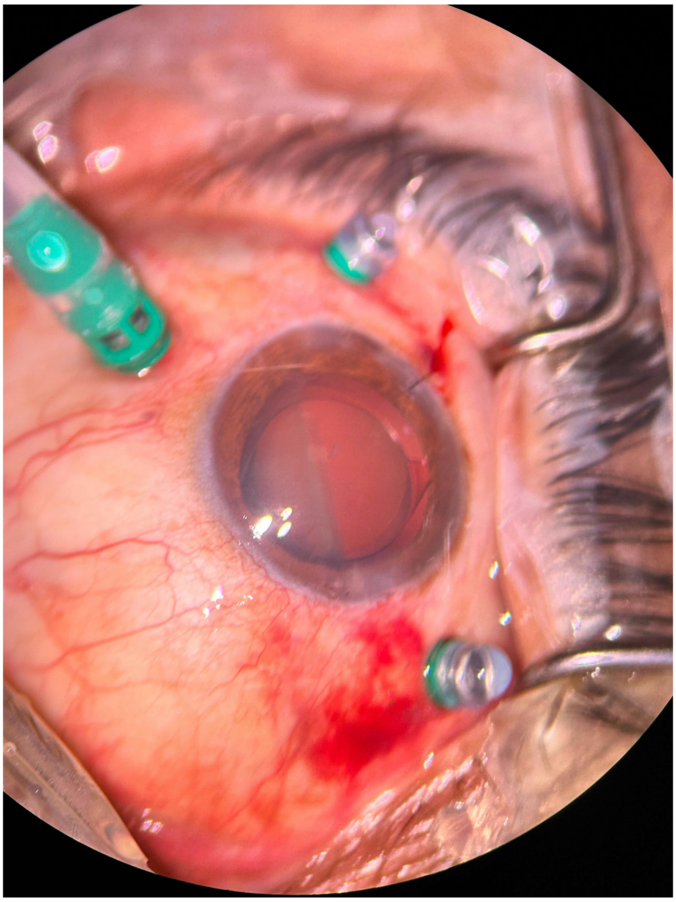

Figure 2. Perpendicular placement of the infusion cannula.

Group 2 suffered from postoperative cataract (p= 0.723). While none of patients suffered from postoperative ERM in Group 1, whereas in 4 patients had postoperative ERM in Group 2 (p= 0.106). Postoperative macular edema developed in 1 patient in Group 2. None of the patients in Group 1 suffered from macular edema (p=1.00).

Discussion

The smaller diameter for the instruments used in vitrectomy surgery has advantages but it may cause some unpredicted complications [10]. The incidence of IRB with the use of 20 G vitrectomy cannula is reported to range between 0% to 7.2%. Whereas the incidence of IRB has been reported to range between 0% to 15.8% if 25 G vitrectomy cannula is used [7,11,12]. It is unclear how many of them really is jet stream related but this type of injury has some known serious complications such as retinal detachment [7,8,13]. Also, jet stream from infusion cannula may cause another important and overlooked damage to macula and optic nerve head. We have experienced similar complications. We have observed rebound hypotonia due to the position of the infusion cannula. For this reason, we placed infusion cannula at an right angle to the sclera to avoid rebound hypotonia. However, this resulted in poor postoperative visual acuity. Our oobservations obligated us to investigate and compare these two techniques. The results of the present study showed that the infusion cannula directed toward posterior pole in the the patients resulted in poor postoperative visual acuities. Zacharias et al. reported a case that showed macular hole enlargement due to fluid flow effect towards to the posterior pole [14]. Angled positioning of the infusion cannula has some challenges. One of them is rebound hypotonia. The tip of the cannula may clog by vitreous base with the maneuvers which results in IPC system impeding and stoping the fluid flow. Furthermore, intraoperative maneuvering of the cannula may result in a damage to the posterior of the lens. The infusion cannula must be inserted at a right angle to the sclera and towards the posterior ocular pole to avoid these complications but our results show that this strategy is more harmful. Complete shaving of the vitreous base around the infusion cannula at the beginning of the surgery and gentle globe deviation and scleral indentation may resolve these issues. The our results showed that occurrence of postoperative cataract, macular edema and epiretinal membrane were comparable in both cannula positions. We did not observe any IRBs in any of our patients. The retina could have been examined by optic coherence tomography (OCT) and microperimetry to show subtle injuries accurately. The retrospect,ve nature of the study prevented performing both OCT and visual field examinations in both pre- and postoperative period. Therefore, prospective studies are needed to address defining subtle injuries that we have emphasized through our results.

There have been some valuable efforts by proposing different modifications in cannula designto reduce the jet stream associated injuries on retina. Bent cannulas, cannulas with different angled side ports, and cannulas with blocked distal tip and spark plug designs are among the most prominent ones. These type of modifications have some challenges in terms of manufacturing. Furthermore, introduction of the cannula to the eye globe is also technically demanding [2,15]. We advise to use these new type of infusion cannulas. Also, we suggest placing the infusion cannula at an angled manner to avoid the flow force and shear on the posterior pole.

Conclusion

In conclusion, the the results of the present study showed that infusion cannula associated jet stream may reduce postoperative visual acuity. Although its not clear whether this effect is permanent or not, it is of paramount importance to take some preventive measures to avoid these type of injuries. The current study has limitations. It is a retrospective study and the results were evaluated primarily by examining the short term effects on VA. The participants had heterogenous eye conditions. Larger prospective studies with the OCT and microperimetry examinations are needed to better understand the jet stream related injuries from infusion cannula on posterior pole.

Ethical approval

Ethical approval was obtained for this study from the Inonu University Health Sciences Non-Interventional Clinical Research Ethics Committee (Decision number: 2024/6681).

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