Original Article

Prognostic Role of Optical Coherence Tomography in Outcome of Idiopathic full thickness Macular Hole Surgery

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Abstract

Objective: To assess the prognostic value of Optical Coherence Tomography indices preoperatively in the outcome of idiopathic full-thickness macular hole surgery.

Materials & Methods: A Quasi-experimental study with a non-probability sampling technique was carried out at Al-Ibrahim Eye Hospital, Karachi from June 2019 to Feb 2020. Patients between 50 to 70 years of age, including both genders with a full-thickness idiopathic macular hole on Optical Coherence Tomography (OCT), were included while patients with secondary causes of a macular hole like trauma, myopia, detachment of retina with macular hole, macular hole with other causes of poor vision like corneal scaring, Age-related macular degeneration and diabetic retinopathy were excluded. OCT measurements are basal diameter, the height of the macular hole, right and left arm length, and derived indices are macular hole index (MHI) and hole form factor (HFF).

Results: A total of 33 patients including 23 (69.6%) males and 10(30.3%) females with idiopathic full-thickness macular holes were taken. The patients' mean age was 55.25±6.9. Among 33 patients, MHI (>0.5) was found in 21(63.6%) patients while 12 (36.3%) patients had MHI (< 0.5). In 25 patients HFF calculation was possible. 17(68%) patients had HFF (>0.9) while 8 (32%) patients had HFF (< 0.9). Anatomical and visual outcomes were assessed at 1st and 3rd month follow-up. Of 21 patients for MHI >0.5, vision improved (i.e., ≥ 6/18) in 15 (71.4%). Similarly, out of 17 patients for HFF > 0.9, 13 (76.47%) patients had improved vision post-operatively.

Conclusion: OCT-based measured indices are a useful prognostic indicator of the postoperative functional and anatomical outcome of macular hole surgery.

Keywords: OCT, Macular Hole, Hole Forming Factor, Macular Hole Index.

Introduction

A macular hole located in the center of the macula is a retinal defect involving all neurosensory layers of the retina causing profound impairment of vision. Macular holes can be idiopathic macular holes (IMH), which are caused by traction of vitreous on the center of fovea anteroposteriorly and tangentially by ILM.[1] It is common around 6 and 7 decades of life.[2] In the general population IMH prevalence is 7.8/100,000. Female predominance is significantly found.[3] In India the prevalence of macular holes is reported at 0.17%. According to Beijing Eye Study, the macular holes rate is nearly 1.6 out of 1000 elderly Chinese.[4]

Trauma and Myopia are other causes of the macular hole but the idiopathic macular hole is the most common cause.[5] Macular holes have no definite treatment before the introduction of Vitrectomy and few macular holes close by themselves.[6] Commonly used procedure to treat macular hole commonly is Pars plana vitrectomy followed by internal limiting membrane peeling (VILMP), having an 80 to 95% rate of success.[6] A conventional VILMP surgery consist of a three-port pars plana Vitrectomy (23-gauge or 25-gauge), followed by an internal limiting membrane (ILM) peeling, either with or without staining, and air which is mostly used as tamponade.[7] It was first introduced in 1991 by Kelly and Wandel.[8] Nowadays OCT (optical coherence tomography) has been playing a pivotal role in macular hole diagnosis and analyzing its preoperative role in visual and anatomical outcomes of macular hole surgery.[9] Ip et. al. in 2002 for the very first time published a study that showed the preoperative use of OCT to analyze macular holes.[1,10] After that many studies are available that illustrate the preoperative predictive role of measurements of macular hole and OCT parameters like HFF, MHI, and THI (tractional hole index) with functional and anatomical outcomes after macular hole surgery.[11] Spectral-domain OCT (SD-OCT) is now used as a key device in macular hole diagnosis before surgery, estimating its dimensions, macular hole index calculation (used in predicting the postoperative closure rates and visual acuity) and in postoperative follow-ups to confirm the hole closure.[12] MHI is the ratio of the height of the hole to the basal diameter as visualized by cross-sectional OCT images[13] if it is equal to or more than 0.5 then it is associated with good functional and anatomical outcomes and in this way it helps us to foretell the outcome of macular hole surgery before surgical intervention.[14,15]

To predict the functional outcomes of macular hole surgery the OCT indices like MH index (MHI), and hole form factor (HFF: left arm length + right arm length/base diameter [BD]) can be helpful.[16] Hole form factor (HFF) is the ratio of right arm length and left arm length to the basal diameter of the macular hole. The basal diameter and minimum diameter were not affected by the time period that the patient had symptoms.[15] So OCT not only helps us in proper diagnosis, but the planning of surgery based on preoperative OCT parameters helps in evaluating functional and anatomical outcomes.[15]

To the best of our knowledge very limited research work has been reported from Pakistan regarding the role of OCT indices in outcomes of macular hole surgery. Our study aims to evaluate the relationship between preoperative OCT indices like MHI and HFF with postoperative visual acuity and the rate of closure of macular holes after full-thickness macular hole surgery.

Materials and Methods

It was a Quasi-experimental study with a non-probability convenience sampling technique carried out at Al-Ibrahim Eye Hospital, Karachi from June 2019 to February 2020. The sample size was calculated from the OpenEpi sample calculator with statistical conditions of 95% confidence interval and 5% margin of error. The effect size was considered as 0.4 with 80% power of the test. The required sample size generated from the formula was 33. Patients between 50 to 70 years of age, including both genders with OCT, who confirmed full-thickness idiopathic macular hole were included in the study. Exclusion Criteria were macular hole secondary to myopia and trauma, Retinal detachment with macular hole, previously operated for a macular hole, Macular hole associated with miscellaneous other causes of decreased vision like corneal scaring, ARMD, diabetic retinopathy, etc. OCT measurements like maximum diameter at base (basal diameter), the height of macular hole, nasal and temporal arm lengths were taken indices were derived from these measurements like Macular hole index (height of macular hole/ basal diameter of macular hole), HFF (nasal arm length + temporal arm length /basal diameter). It has been found that macular hole index (MHI) > 0.5 is associated with good functional and anatomical outcomes on the other hand Hole form factor (HFF) >0.9 is associated with good functional outcomes.

Procedure of Macular Hole Surgery: Single surgeon who is a Vitro retina specialist and has an experience of 5 years in macular hole surgery has performed surgery on all patients to reduce the chances of bias. 23G Vitrectomy system is used for performing surgeries and to stain ILM brilliant blue (BBG) dye was used. After air-fluid exchange staining of ILM was done to get better staining and reduce the dye spread. About 2-disc diameter in size, ILM peeling was done after its staining. In end, an exchange of air-fluid was done and the air is used as intraocular tamponade in the vitreous cavity. Sulphur hexafluoride (SF6) 20% gas was used as intraocular tamponde.

For 1 week all patients were advised to maintain a prone position. After surgery patients were followed up at 4, 8, and 12 weeks. OCT scans at 12 weeks were taken for analysis Additional surgical information was also gathered like complications related to surgery and any additional procedure such as cataract surgery.

Statistical Analysis:

Data were analyzed by using SPSS V.22.0. Mean and Standard deviation was calculated for continuous variables while categorical variable was represented in form of frequency and percentage. Pie charts and Doughnut charts were made to represent the status of the Hole forming factor (HFF) and Macular hole index (MHI). Fisher's exact test was used to analyze pre and post-operative visual acuity. P-value < 0.05 was considered as statistically significant.

Results

A total of 33 patients with macular holes in idiopathic were recruited for the study. The patient's mean age was 55.25 ± 6.9. There were 23 (69.6%) males and 10 (30.3%) females. The average macular hole index was 1.54 ± 0.54. Among 33 patients, 21 (63.6%) patients with MHI > 0.5 were found and 12 (36.3%) patients observed with MHI <0.5. **(Figure 1)**

Of 21 patients (MHI > 0.5), 13 (61.90%) patients were observed to have macular hole closure and 8 (38.09%) showed failed closure postoperatively. **(Figure 2)**

There were 25 patients whose HFF calculation was possible. In 17(68%) patients HFF >0.9 was found and in 8 (32%) patients HFF< 0.9 was observed. **(Figure 3)**

Of 17 patients (HFF >0.9), 10 (58.82%) patients showed macular hole closure and 7 (41.17%) were remain unclosed. **(Figure 4)**

At the end of primary macular hole surgery, both anatomical and visual outcomes were assessed. Visual acuity was performed at 1st and 3rd month post-operative follow-up. Of 21 patients for MHI > 0.5, 15 (71.4%) patients improved in their vision (≥ 6/18). Similarly, out of 17 patients for HFF > 0.9, 13 (76.47%)

patients enhanced their vision post-operatively. Pre and post-operative visual acuity were shown in **Table 1.**
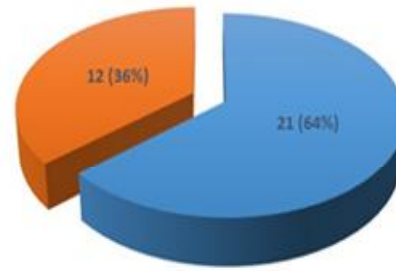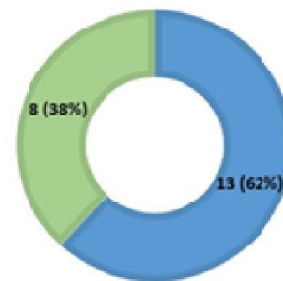

■ MHI > 0.5   ■ MHI ≤ 0.5

Figure 1: Macular Hole Index (MHI)

■ Macular Hole Closure   ■ Macular Hole Unclosed

Figure 2: Status of Macular Hole for MHI >0.5

■ HFF > 0.9   ■ HFF ≤ 0.9

Figure 3: Hole Forming Factor (HFF)

■ Macular Hole Closure   ■ Macular Hole Unclosed
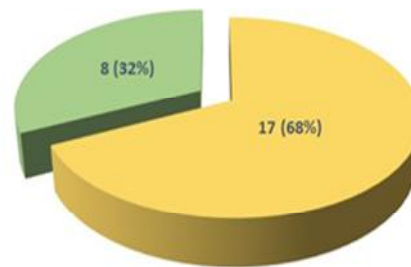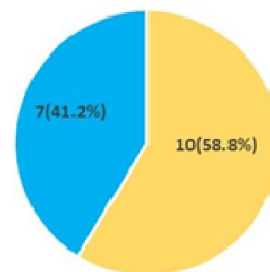
Figure 4: Status of Macular Hole for HFF > 0.9

Table 1: Pre and Post-operative visual acuity for MHI > 0.5 and HHF > 0.9

For MHI > 0.5						
Pre-op VA	**Count**	**Percent**	**Post-op VA**	**Count**	**Percent**	**P-value**
6/6 to 6/18	4	19.05	6/6 to 6/18	15	71.43	0.001
< 6/18 to 6/60	10	47.62	< 6/18 to 6/60	4	19.05	
< 6/60	7	33.33	< 6/60	2	9.52	
Total	21	100.00	Total	21	100.00	
For HHF > 0.9						
Pre-op VA	**Count**	**Percent**	**Post-op VA**	**Count**	**Percent**	**P-value**
6/6 to 6/18	3	17.65	6/6 to 6/18	13	76.47	0.001
< 6/18 to 6/60	9	52.94	< 6/18 to 6/60	3	17.65	
< 6/60	5	29.41	< 6/60	1	5.88	
Total	17	100.00	Total	17	100.00	

Discussion

The purpose of the present study was to evaluate the relationship between preoperative OCT indices like MHI and HFF with postoperative visual acuity and the rate of closure of macular holes after full-thickness macular hole surgery. Good functional outcomes of macular hole surgery may not always correspond with the anatomical success of macular holes.[17] Further MH study by OCT parameters gives us more knowledge about its geometry and other characteristics.[18]

Pars Plana Vitrectomy, Peeling of ILM, and the gas used as tamponade are the standard surgical procedure for the treatment of macular holes. With the advancements in staining techniques and the introduction of vital dyes, ILM peeling has now become much easier.[19]

After surgery patient should be called for examination at regular time intervals with OCT to assess for anatomical and visual outcomes. Amsler grid can be used by the patient to monitor their visual outcomes at home.[20]

Most researchers have also studied the relationship between preoperative OCT indices and postoperative visual and anatomical outcomes after MH surgery.[19] along with it. Villate et al.[21] have also examined the association with post-surgical OCT findings.

In the present study, both anatomical and visual outcomes were assessed post-operatively at follow-ups. Post-operative follow-up visual acuity was performed using Snellen's chart. Improvement was seen in 28 patients with different levels of visual acuity with MHI >0.5 and HFF >0.9. Wakely et al.[22] matched separate techniques of MH measurements in the same cohort of patients They established that macular hole index, basal diameter, and minimum hole diameter were markedly associated with good anatomical outcomes, and preoperatively it might be helpful to

foretell the anatomical and visual outcomes of macular hole surgery. We had taken the BCVA at 3 months to negate the effects of cataract and cataract surgery on the visual outcomes of patients in our study.

Several other studies described the correlation between OCT indices and functional and anatomical outcomes of macular hole surgery.

Puliafito[23] first reported the Hole form factor (HFF). He documented that the ratio between the basal diameter of the hole and overlying tissue had more prognostic value as far as anatomical outcomes are concerned rather than the only diameter of the base. Puliafito documented an 80% good anatomical rate in those patients having HFF more than 0.9 while in patients with less HFF under 0.5 this success rate falls to 25%. The relationship between successful anatomical outcome and HFF was reported to be statistically significant.[23]

Ullrich et al.[24] documented that MHs having HFF > 0.9 had a high anatomical success ratio post-surgery, while patients with HFF < 0.5 had a low rate of macular hole closure Ullrich S, Other than similar anatomical outcomes like that of Puliafito and coworkers. Ullrich too reported a strong association between HFF and macular hole closure rate. This high success rate as compared to Puliafito et al.[23] results show the probability of the presence of co-existing epiretinal membranes along with the inner limiting membrane that is also peeled in the course of macular hole surgery.

Our study also showed that there were 25 patients where HFF calculation was possible. We found 17(68%) patients with HFF > 0.9 and 8 (32%) patients with HFF ≤ 0.9 were observed. Of 17 patients (HFF > 0.9), 10 (58.82%) patients showed macular hole closure and 7 (41.17%) were remain unclosed. Haritoglou et al[17] also reported the similar results as we find in our

study that higher values of HFF are associated with good post-surgical outcomes

Feroz et al.[9] reported that MHI >0.5 is associated with good visual outcomes. Haroon Tayyab et. al.[25] also reported MHI of >0.5 was taken as a significant indicator for better macular hole surgical outcomes. These results are also comparable to this study.

Kusuhara et al.[11] also used MHI measurements which is the ratio of macular hole height to the basal diameter of MH to predict the functional outcomes of macular hole surgery. His results also showed the same results that MHI >0.5 is associated with good functional outcomes.

The management of all macular holes was done by the same surgical method and the same open access imaging software was used for taking measurements concomitantly and this was the benefit of our study. Its non-probability and small sample were the main hindrances to the present study.

Conclusion

OCT is used to calculate MHI and HFF and these OCT-based measured indices are a useful prognostic indicator for the postoperative functional and anatomical outcome of macular hole surgery.

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