Vitrectomy for Myopic Traction Maculopathy

Giacomo Panozzo, MD; Andrea Mercanti, MD

Objective: To describe the results of vitrectomy in highly myopic eyes affected by a form of posterior vitreous traction termed myopic traction maculopathy (MTM).

Methods: In this retrospective case series, 24 highly myopic eyes with MTM underwent vitrectomy and release of vitreoretinal traction without final fluid/gas exchange. Nine eyes (37.5%) received a combined phaco-vitrectomy. Mean patient age was 58 years, mean refractive error was −16.8 dioptic spherical equivalent, and preoperative visual acuity ranged from 20/400 to 20/32 (mean, 20/80). Mean follow-up was 29.6 months.

Results: Twenty-three (95.8%) of 24 eyes had complete and stable resolution of MTM after a mean of 4.4 months. Mean visual improvement was 2.5 Snellen lines (range, 0 to 6 lines). Five eyes (20.8%), despite achieving complete retinal flattening, developed a macular hole that did not progress to macular detachment during follow-up.

Conclusions: Vitrectomy without fluid/gas exchange leads to stable resolution of MTM and good visual improvement. Posterior retinal detachment probably precedes macular hole formation in highly myopic eyes.

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myopic eyes with MTM involving the fovea. Because these eyes may have had concomitant causes of visual deficiency, vitrectomy was selected only when MTM was judged as (1) the main cause of a recent decrease in visual function; (2) an important cause of a stable visual impairment; and (3) an unstable condition jeopardizing the remaining vision. We therefore excluded from surgery eyes with poor visual acuity due to diffuse macular chorioretinal atrophy or large Fuchs spots, where no significant visual improvement could be expected. To better compare our surgical case series with the others previously published that only considered eyes with isolated shallow foveal detachment, or MTM threatening but not involving the fovea) were excluded from the present series.

A total of 24 eyes were included in this study (Table 1). The severity of myopic changes at the posterior pole was graded according to the 3-step classification proposed by Avila et al18 as shown in Table 2.

Table 1. Characteristics and Surgical Results

<table>
<thead>
<tr>
<th>Eye/Patient Sex/ Patient Age, y</th>
<th>SE</th>
<th>PVA</th>
<th>PVD</th>
<th>M</th>
<th>Surgery</th>
<th>Follow-up, mo</th>
<th>Flat</th>
<th>Lines Gained</th>
<th>Surgical Results</th>
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<tbody>
<tr>
<td>1/F/34</td>
<td>−15</td>
<td>20/50</td>
<td>No</td>
<td>2</td>
<td>PPV</td>
<td>19</td>
<td>3</td>
<td>3</td>
<td>Foveal reattachment</td>
</tr>
<tr>
<td>2/M/40</td>
<td>−13</td>
<td>20/100</td>
<td>No</td>
<td>4</td>
<td>PPV</td>
<td>15</td>
<td>6</td>
<td>0</td>
<td>Hole</td>
</tr>
<tr>
<td>3/F/42</td>
<td>−19</td>
<td>20/400</td>
<td>Yes</td>
<td>4</td>
<td>PPV</td>
<td>36</td>
<td>1</td>
<td>0</td>
<td>Hole</td>
</tr>
<tr>
<td>4/F/58</td>
<td>−16</td>
<td>20/100</td>
<td>Yes</td>
<td>4</td>
<td>PPV</td>
<td>25</td>
<td>4</td>
<td>2</td>
<td>Foveal reattachment</td>
</tr>
<tr>
<td>5/F/56</td>
<td>−18</td>
<td>20/400</td>
<td>Yes</td>
<td>4</td>
<td>PPV</td>
<td>48</td>
<td>5</td>
<td>1</td>
<td>Hole</td>
</tr>
<tr>
<td>6/F/65</td>
<td>−18</td>
<td>20/200</td>
<td>Yes</td>
<td>2</td>
<td>PPV</td>
<td>17</td>
<td>2</td>
<td>2</td>
<td>Foveal reattachment</td>
</tr>
<tr>
<td>7/F/62</td>
<td>−18</td>
<td>20/100</td>
<td>Yes</td>
<td>3</td>
<td>PPV</td>
<td>57</td>
<td>9</td>
<td>5</td>
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<td>8/F/62</td>
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<td>PPV</td>
<td>59</td>
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<td>9/F/69</td>
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<td>17</td>
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<td>1</td>
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<tr>
<td>10/F/55</td>
<td>−14</td>
<td>20/100</td>
<td>Yes</td>
<td>2</td>
<td>PPV</td>
<td>10</td>
<td>12</td>
<td>2</td>
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<tr>
<td>11/F/71</td>
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<td>20/50</td>
<td>No</td>
<td>3</td>
<td>PPV</td>
<td>43</td>
<td>1</td>
<td>2</td>
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<tr>
<td>12/F/38</td>
<td>−14</td>
<td>20/40</td>
<td>No</td>
<td>2</td>
<td>PPV</td>
<td>32</td>
<td>1</td>
<td>0</td>
<td>Foveal reattachment</td>
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<tr>
<td>13/F/72</td>
<td>−14</td>
<td>20/200</td>
<td>Yes</td>
<td>2</td>
<td>PPV</td>
<td>15</td>
<td>3</td>
<td>0</td>
<td>Foveal reattachment</td>
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<tr>
<td>14/F/32</td>
<td>−16</td>
<td>20/32</td>
<td>No</td>
<td>3</td>
<td>PPV</td>
<td>9</td>
<td>1</td>
<td>0</td>
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<tr>
<td>15/F/41</td>
<td>−12</td>
<td>20/32</td>
<td>No</td>
<td>2</td>
<td>PPV</td>
<td>48</td>
<td>3</td>
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</tr>
<tr>
<td>PPV results</td>
<td>−16.3</td>
<td>20/80</td>
<td>Yes</td>
<td>3</td>
<td>PPV+phaco</td>
<td>30</td>
<td>3.9</td>
<td>1.8</td>
<td></td>
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<tr>
<td>16/F/66</td>
<td>−18</td>
<td>20/50</td>
<td>Yes</td>
<td>3</td>
<td>PPV+phaco</td>
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<td>7</td>
<td>0</td>
<td>Hole</td>
</tr>
<tr>
<td>17/F/66</td>
<td>−19</td>
<td>20/400</td>
<td>Yes</td>
<td>3</td>
<td>PPV+phaco</td>
<td>8</td>
<td>2</td>
<td>4</td>
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</tr>
<tr>
<td>18/F/32</td>
<td>−12</td>
<td>20/100</td>
<td>No</td>
<td>2</td>
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<td>36</td>
<td>11</td>
<td>5</td>
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<td>19/M/44</td>
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<td>20/83</td>
<td>No</td>
<td>2</td>
<td>PPV+phaco</td>
<td>40</td>
<td>3</td>
<td>3</td>
<td>Foveal reattachment</td>
</tr>
<tr>
<td>20/M/44</td>
<td>−18</td>
<td>20/63</td>
<td>No</td>
<td>2</td>
<td>PPV+phaco</td>
<td>39</td>
<td>3</td>
<td>3</td>
<td>Foveal reattachment</td>
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<tr>
<td>21/F/79</td>
<td>−15</td>
<td>20/200</td>
<td>No</td>
<td>4</td>
<td>PPV+phaco</td>
<td>10</td>
<td>7</td>
<td>0</td>
<td>Hole</td>
</tr>
<tr>
<td>22/F/79</td>
<td>−13</td>
<td>20/202</td>
<td>Yes</td>
<td>4</td>
<td>PPV+phaco</td>
<td>8</td>
<td>5</td>
<td>3</td>
<td>Foveal reattachment</td>
</tr>
<tr>
<td>23/F/77</td>
<td>−26</td>
<td>20/400</td>
<td>No</td>
<td>3</td>
<td>PPV+phaco</td>
<td>52</td>
<td>3</td>
<td>6</td>
<td>Foveal reattachment</td>
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<tr>
<td>24/F/77</td>
<td>−22</td>
<td>20/200</td>
<td>No</td>
<td>3</td>
<td>PPV+phaco</td>
<td>53</td>
<td>5</td>
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<td>PPV+phaco results</td>
<td>−17.6</td>
<td>20/80</td>
<td></td>
<td>2.9</td>
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<td>28.3</td>
<td>5.1</td>
<td>3.3</td>
<td></td>
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<tr>
<td>Total mean results</td>
<td>−16.8</td>
<td>20/80</td>
<td></td>
<td>2.7</td>
<td></td>
<td>29.6</td>
<td>4.4</td>
<td>2.5</td>
<td></td>
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Table 2. Avila et al18 Classification of Myopia

<table>
<thead>
<tr>
<th>Grade</th>
<th>Characteristics</th>
</tr>
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<tbody>
<tr>
<td>M0</td>
<td>Normal-appearing posterior pole</td>
</tr>
<tr>
<td>M1</td>
<td>Choroidal pallor and tessellation with posterior pole staphyloma</td>
</tr>
<tr>
<td>M2</td>
<td>Choroidal pallor and tessellation with posterior pole staphyloma and lacquer cracks</td>
</tr>
<tr>
<td>M3</td>
<td>Choroidal pallor and tessellation with posterior pole staphyloma and lacquer cracks and focal areas of deep choroidal atrophy</td>
</tr>
<tr>
<td>M4</td>
<td>Choroidal pallor and tessellation with posterior pole staphyloma and lacquer cracks and focal areas of deep choroidal atrophy (bare sclera)</td>
</tr>
<tr>
<td>M5</td>
<td>Posterior pole showing large geographic areas of deep choroidal atrophy</td>
</tr>
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</table>

Abbreviations: flat, months for retinal flattening; M, myopic changes at posterior pole according to Avila et al18 classification (see Table 2); phaco, phacovitrectomy; PVA, preoperative visual acuity; PVD, posterior vitreous detachment; PPV, pars plana vitrectomy; SE, spherical equivalent in diopters.
OCT EXAMINATION TECHNIQUE

All eyes were tested with Stratus OCT software version 2 or 3 (Carl Zeiss Meditec, Dublin, Calif) using the “radial lines” mode with the patient fixating on the central fixation light. With this modality, 6 consecutive scans were radially oriented every 30° to create a general picture of the entire posterior pole. This scan was repeated with scan lengths of 6 and 9 mm in an effort to visualize the origin of the traction, often at the borders of the staphyloma. Finally, the rough scans were directly analyzed without software processing to avoid alterations of the eye profile or loss of visibility of small anomalies.

SURGICAL TECHNIQUE

A standard 20-gauge 3-port pars plana vitrectomy was performed in all eyes under local anesthesia. The central vitreous core was first removed, paying particular attention to visualizing any vitreoretinal adhesions (focal or diffuse) and detecting or generating a fluctuating and free posterior hyaloid membrane (complete PVD) with active suction. Vitrectomy was then extended to the midperiphery without attempts to reach the vitreous base.

All focal or diffuse vitreoretinal adhesions and epiretinal membranes were removed, if possible, to the borders of the...
staphyloma, often with the help of triamcinolone acetate. In many cases, multiple injections of dye showed a multilayered vitreous cortex variably adherent to the retina. The internal limiting membrane (ILM), stained with indocyanine green (5 mg/mL), was finally removed in the macular area. Neither gas nor any other form of vitreous tamponade was used.

All patients were followed up every 2 months with complete ophthalmic evaluation and OCT imaging until the retina was completely flat, and every 6 months thereafter. Informed consent was obtained from all patients, and data collection was performed in accordance with all country laws.

STATISTICAL ANALYSIS

The mean and median preoperative and postoperative values of best-corrected visual acuity were compared using the non-parametric Wilcoxon signed rank test, paired t test, and sign test of matched pairs.

ANATOMICAL RESULTS

In 23 (95.8%) of 24 eyes, total resolution of MTM was obtained in a mean time of 4.4 months (range, 1 to 12 months) (Figure 1 and Figure 2). Four of the 5 eyes with associated shallow retinal detachment and 1 eye with simple retinoschisis, though achieving complete retinal flattening, developed a macular hole during the sealing process (Figure 3). One eye remained unchanged. In this eye, complete peeling was aborted because of the strength of the traction and surgical maneuvers that jeopardized retinal integrity. In 18 eyes (78.6%), retinal microfolds at the arterial crossing were visible after surgery or improved as compared with the preoperative condition (Figure 4). All 23 eyes with a flattened retina remained stable during follow-up. The 5 eyes with a macular hole remained flat and never developed retinal detachment. None of the eyes developed retinal detachment or other intraoperative or postoperative vision-threatening complications. During follow-up, 2 phakic eyes developed a significant cataract and underwent phacoemulsification.

VISUAL RESULTS

The mean visual improvement in 23 eyes was 2.5 Snellen lines (range, 0 to 6 lines). As indicated in Table 3, 16 eyes (69.6%) had a visual improvement and 7 eyes (30.4%) remained stable after surgery. Ten eyes (43.5%) improved 3 or more lines and 4 eyes (17.4%) improved more than 4 lines. Eyes that underwent vitrectomy alone had
a mean improvement of 1.8 lines (range, 0 to 5 lines), and the eyes that underwent phacovitrectomy had a mean improvement of 3.3 lines (range, 0 to 6 lines). The differences between preoperative and postoperative mean and median values were statistically significant ($P<.001$) in all groups (Table 3).

**INTRAOPERATIVE FINDINGS**

Although a Weiss ring was detected preoperatively in 14 eyes, during surgery all eyes had a thin, fenestrated membrane covering the posterior pole and adhering to the margins of the staphyloma. This membrane was sometimes multilayered and focally attached to the retina in 1 or more points inside the staphyloma. No histological analyses were carried out on the specimens. They were, however, judged in terms of posterior hyaloid remnants according to consistency and appearance and by the fact that they were seen well with triamcinolone acetate but did not stain with indocyanine green. Finally, we peeled the indocyanine green–stained ILM, which was often incomplete and easily breakable and sometimes focally elevated from the underlying retina.

### COMMENT

This large retrospective case series of 24 highly myopic eyes with MTM demonstrates that vitrectomy with release of vitreoretinal traction leads to stable anatomical recovery and visual improvement and that this result can be achieved without the use of vitreal tamponade. Previously published smaller surgical case series and case reports have reported similar results but with the adjunct of gas tamponade and prone positioning. In this study, we obtained an equal or higher rate of anatomical resolution (95.8%) without flattening the retina with gas.

A preliminary observation of these positive surgical results relates to the term in the literature for this condition: *foveal retinoschisis*. The term *inner* or *outer retinal schisis* defines a complete separation between retinal layers, responsible for an irreversible and total loss of retinal function.

On the contrary, all published case series of foveal retinoschisis report a good visual improvement. This retinal damage is consequently not a schisis but retinal swelling with fluid accumulation. This condition, in our opinion, would therefore be better described by another name. In this article, as well as in our previous article on this matter, we propose the name MTM.

Of relevance is the high female prevalence of 87.5% in this series, not noted by other authors, but similar to all the other published series (79.6% of a total of 68 eyes). This prevalence is higher than the female prevalence of 56% to 60% reported in the literature for high myopic vitreopathy.

Regarding visual acuity (Table 1 and Table 3), the mean improvement in this series was 2.5 lines in the whole group, with a mean improvement of 1.8 lines in cases of vitrectomy and 3.3 lines in cases of combined phacovitrectomy, where surely the lens extraction played a role. Although a complete retinal flattening was achieved in all eyes, the wide range of visual change (0 to 6 lines) reflects the different grade of posterior chorioretinal atrophy (“M” column in Table 1) and probably other factors such as amblyopia or chronicity of retinal damage from MTM. The mean improvement in our group is in the same range of the other published case series (from 2 to 3.6 lines).

In all the eyes described in this series, the retina slowly flattened in a mean of 4.4 months. Others have similarly observed this slow process. Even the associated retinal detachment in 5 eyes resolved over time. Four of them, however, along with 1 eye without associated retinal elevation, developed a full-thickness macular hole; none of these flat holes progressed to macular retinal detachment during follow-up.

As hypothesized by other authors and also observed in 2 eyes, our findings strongly suggest that macular detachment precedes hole formation in highly myopic eyes. Other authors hypothesize that this tangential traction could be compared with the traction responsible for the formation of an idiopathic macular hole, but with the difference of a very concave shape of a myopic eye. In the presence of this profile, tangential epiretinal traction could first affect the inner retinal layers leading to the picture known as foveoschisis, comparable with the small foveolar detachment known as an impending hole in nonmyopic eyes. Depending on the depth of the staphyloma and the strength of the traction, this condition might be followed by a detachment of all retinal layers (macular detachment) and, finally, by the formation of a full-thickness hole. The surgical resolution of traction during the first stages of this process would allow the retina to flatten again, but in advanced cases and/or deep staphyloma, a full-thickness macular hole might develop during the process. Once sealed, the hole without traction would remain stable over time. Further studies are needed to confirm this mechanism.

The excellent and stable anatomical results after surgical release of traction demonstrate that this is the main

### Table 3. Changes in VA (logMAR)

<table>
<thead>
<tr>
<th></th>
<th>Total Group (23 Eyes*)</th>
<th>PPV (14 Eyes*)</th>
<th>PPV + Phaco (9 Eyes)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>VA (logMAR)</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Preoperative mean†</td>
<td>0.6</td>
<td>0.6</td>
<td>0.6</td>
</tr>
<tr>
<td>Median†</td>
<td>0.7</td>
<td>0.7</td>
<td>0.7</td>
</tr>
<tr>
<td>Range</td>
<td>1.1 to 0.2</td>
<td>1.1 to 0.2</td>
<td>1.1 to 0.2</td>
</tr>
<tr>
<td>Postoperative mean†</td>
<td>0.43 ($P&lt;.001$)</td>
<td>0.5 ($P=.003$)</td>
<td>0.38 ($P=.001$)</td>
</tr>
<tr>
<td>Median†</td>
<td>0.5 ($P&lt;.001$)</td>
<td>0.5 ($P=.004$)</td>
<td>0.4 ($P=.008$)</td>
</tr>
<tr>
<td>Range</td>
<td>1.1 to 0.1</td>
<td>1.1 to 0.1</td>
<td>1.0 to 0.1</td>
</tr>
<tr>
<td>VA improvement, stable, No. (%)</td>
<td>7 (30.4)</td>
<td>5 (35.7)</td>
<td>2 (22.2)</td>
</tr>
</tbody>
</table>

*Aborted surgery not included (eye 8 in Table 1).
†The difference between preoperative and postoperative mean and median values was statistically significant using a paired $t$-test and Wilcoxon signed rank test (data not reported).
cause of MTM and that the presence of myopic staphylo-
oma and retinal stretching are not sufficient to gen-
erate this anomaly.7,22 We observed intraoperatively
that this traction is generated by sheets of posterior vitreous
cortex still adherent to the retina and bridging the
borders of the staphyloma both in the presence of false PVD
(large liquefied lacunae or posterior pre cortical vitreous
pocket) or in cases of true PVD (hyaloid splitting). This
membrane is often thick and light scattering and could
be a further cause of visual impairment. Since the depth
of the staphyloma determines the distance between the
retinal surface and the membrane, this sheet of tissue is
often invisible to OCT, detectable only in few cases with
long scans (Figure 5).

As demonstrated by Kwok et al,11 ILM peeling is prob-
ably not essential in these eyes but, in our opinion, re-
ains an effective method for ascertaining the absence
of any residual traction on the retinal surface. In our opin-
ion, the border of ILM peeling with subsequent periph-
eral contraction produces the increase in arteriolar mi-
crofolds noticed by Ikuno et al,13 Sayanagi et al,12 and us.

Regarding the surgical indication for eyes with MTM,
while major changes were found in patients complaining
of recent visual loss, such improvement was also achieved
in patients without reported visual symptoms. It seems rea-
sonable, therefore, to consider surgery in all eyes where
this condition involves the macular area and is judged to
be damaging or jeopardizing visual function.

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tistical analysis.

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