Surgical management of submacular hemorrhage: experience at an academic Canadian centre

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ABSTRACT ●

Objective: To report the anatomical and visual outcomes of patients with thick submacular hemorrhage (SMH) treated with pars plana vitrectomy (PPV), subretinal tissue plasminogen activator (t-PA), and pneumatic displacement.

Design: Single-centre, retrospective case series.

Participants: A total of 99 eyes of 99 consecutive patients with thick SMH secondary to any underlying etiology treated with PPV with subretinal t-PA and pneumatic displacement by 6 vitreoretinal surgeons at St. Michael's Hospital, Toronto, between July 2004 and August 2016.

Methods: All medical records and colour fundus photographs were reviewed for data collection. Blood displacement was evaluated at follow-up visits and classified as complete, partial, or none. Main outcome measures included blood displacement at final follow-up, postoperative Snellen best-corrected visual acuities (BCVA), and complication and recurrence rates.

Results: Patients had a mean age of 77.7 ± 12.3 years and were followed up for an average of 18.4 ± 22.3 months. Wet age-related macular degeneration was the most common etiology associated with thick SMH (80.8%). Complete blood displacement was observed by final follow-up in 85.9% of the cases, partial displacement in 12.1%, and none in 2.0%. Mean logMAR BCVA improved from 2.03 ± 0.81 (Snellen 20/2143) at baseline to 1.80 ± 1.00 (Snellen 20/1262; $p = 0.009$) at final follow-up, and baseline BCVA was a significant predictor of final BCVA ($p < 0.001$). Early postoperative complications included vitreous hemorrhage in 13 eyes and rhegmatogenous retinal detachment in 8. Recurrent SMH was observed in 12 cases.

Conclusions: Vitrectomy with subretinal t-PA and pneumatic displacement seems to be an effective treatment for SMH in terms of blood displacement and visual outcomes.

Submacular hemorrhage (SMH) is a devastating, sight-threatening complication of a range of ocular diseases, most commonly age-related macular degeneration (AMD). Other causes include retinal arterial macroaneurysm (RAM), choroidal neovascularization (CNV) due to high myopia, ocular histoplasmosis, and trauma.[1] Subretinal blood may quickly induce irreversible retinal changes through different mechanisms, including shearing of the photoreceptors by clot retraction, diffusion barrier effect, and direct iron toxicity.[2] The natural course of SMH is variable depending on the etiology, duration, diameter, and thickness of the hemorrhage. Overall, thick SMH that extends beyond the vascular arcades usually has a very poor visual prognosis despite intervention, especially when associated with AMD.[1,3] In most studies, larger size and higher elevation of initial hemorrhage were observed to be inversely related to final visual outcome.[3–5] If left untreated, SMH can eventually result in subretinal fibrous tissue proliferation, atrophic scars, and retinal pigment epithelium (RPE) tears, which are associated with worse visual outcomes.[5]

Surgical techniques for treatment of SMH have evolved significantly over the past few decades. The earliest surgical reports from the 1990s initially described pars plana vitrectomy (PPV) with posterior retinotomy to allow irrigation, aspiration, and/or active removal of subretinal blood clot using intraocular forceps. Results of this approach were disappointing, with poor visual recovery and high complication rates.[6,7] The use of tissue plasminogen activator (t-PA) during vitrectomy was later introduced as a useful adjunct for dilution of toxic blood products and lysis of the clot, resulting in better visual outcomes.[8] A less-invasive approach described by Heriot in 1996 involved the use of intravitreal t-PA and gas with favourable results in terms of blood displacement (85%–100%) and visual gain.[9–11] However, this technique was associated with higher recurrence rates. In addition, evidence that t-PA might not diffuse through the intact retina to reach the subretinal clot has called this approach into question.[9,10,12] Indeed, when intravitreal t-PA with gas was compared to pneumatic displacement alone, similar results in terms of hemorrhage displacement and visual improvement were reported.[13]

To minimize retinal manipulation while allowing maximum contact between t-PA and the subretinal blood clot, a technique consisting of PPV with subretinal t-PA injection without clot manipulation, followed by fluid–

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gas exchange, was developed.[14] This technique allows the clot to be liquefied, and clot displacement from the fovea is facilitated with fluid–air/gas exchange. Slight variations to this procedure were later described, including the use of subretinal t-PA to create a bullous retinal detachment encompassing the entire blood clot.[14–17] Because of its promising results and lower complication rates, thick SMH has been more commonly treated using this procedure. In addition, the use of anti–vascular endothelial growth factor (anti-VEGF) therapy for better control of the underlying ocular condition can be a valuable adjunctive tool to maintain postsurgical results.[15,18] In this study, we report our experience with PPV, subretinal t-PA, and intraocular gas tamponade with and without postoperative anti-VEGF in eyes with thick SMH treated at a large tertiary vitreoretinal centre of excellence in Canada.

Methods

This is a retrospective study of medical charts and colour fundus photographs of 99 consecutive patients who underwent PPV with subretinal infusion of t-PA and pneumatic displacement for treatment of thick SMH at St. Michael's Hospital, Toronto, between July 2004 and August 2016. A thick SMH was defined as blood causing subfoveal elevation of the retina on fundus biomicroscopy examination. This study included patients treated in the era before and after anti-VEGF therapy became available to treat underlying retinal conditions associated with SMH. The use of postoperative anti-VEGF injections was left to the discretion of the treating physician. Patients with an SMH extending beyond the equator were excluded. This study was conducted according to the Declaration of Helsinki and approved by St. Michael's Hospital's research ethics board.

The medical records were reviewed for the following data: age, sex, ocular diagnosis, etiology of SMH, lens status, size and duration of SMH, previous treatment with pneumatic displacement, preoperative and postoperative treatments with anti-VEGF agents and photodynamic therapy (PDT), comorbidities such as hypertension or diabetes mellitus, use of anticoagulant or antiplatelet, Snellen best-corrected visual acuity (BCVA) preoperatively and at follow-up visits, as well as documented intraoperative and postoperative complications. Blood displacement was evaluated by fundus examinations or colour fundus photographs initially 1 week after surgery and at subsequent follow-up visits and was classified as complete, partial, or none. Complete displacement was defined as the absence of blood or a scarce amount under the fovea, and partial displacement as a reduction in the amount of subfoveal blood but with some remaining blood under the fovea, causing retinal elevation. The size of SMH was expressed in disc diameter (DD) and graded as 1–5 DD, 6–10 DD, and >10 DD. Snellen BCVA was converted into logMAR for statistical analysis: counting fingers at 6 feet was converted to 48/1600, counting fingers at 1 foot to 20/8000, hand movements to 20/16,000, and light perception to 20/32,000. Fluorescein angiography, indocyanine green angiography, B-scan ultrasonography, and optical coherence tomography (OCT) were performed at the discretion of the treating physician. However, these tests were not used for analysis because of limited quality, especially in cases of extensive hemorrhages, or lack of a complete set of data for most patients.

The surgical procedures were performed by 6 surgeons (A.R.B., D.R.C., D.T.W., F.A., L.R.G., and R.H.M.) using a similar technique. A standard 3-port PPV was performed, and detachment of the posterior hyaloid was induced. A 39-gauge flexible cannula connected to a viscous fluid injection kit was inserted within the clotted hemorrhagic retinal detachment to access the subretinal space, followed by a slow, controlled injection of t-PA (12.5 μg/0.1 mL) to develop a pocket of subretinal t-PA underneath the macula with further expansion below the inferior vascular arcade. An air–fluid exchange was performed, and the eye was left with air or either SF_6 or C_3F_8 in nonexpansile concentrations. Patients were instructed to remain in a supine position for 1 hour postoperatively and then assume an upright position for 1 week.

Descriptive and statistical analyses were performed using IBM SPSS Statistics for Windows, version 24.0 (IBM Corp, Armonk, N.Y.). Patient characteristics are presented in terms of mean, standard deviation, median, and range or percentage as appropriate. The Mann–Whitney test was used to compare continuous variables, and the χ^2 test was used to compare proportions. Preoperative and postoperative visual acuities were compared with the Wilcoxon signed-rank test. Regression analysis was performed to identify correlations between preoperative BCVA, SMH characteristics, or treatment with anti-VEGF injections and postoperative BCVA. Patients with thick SMH secondary to RAM were excluded from all analysis involving the use of anti-VEGF therapy. Patients who ended up with no light perception were excluded from all visual acuity analysis. Statistical significance was set at $p < 0.05$. The primary outcome was blood displacement at final follow-up. Secondary outcome measures included visual outcomes at 1, 3, 6, and 12 months and at final follow-up and complication and recurrence rates.

Results

A total of 99 eyes from 99 patients were included in this study. Demographics and baseline characteristics are summarized in Table 1. The mean follow-up time was 18.4 ± 22.3 months (median, 12.0 months; range, 1–96 months). Complete displacement was observed by final follow-up in 85 eyes (85.9%), partial displacement in 12 (12.1%), and no displacement in 2 (2.0%). The rate of complete blood displacement at final follow-up based on