Clinical outcomes of 23-gauge vitrectomy may be better than 20-gauge vitrectomy for retinal detachment repair

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Objective: This study compared the clinical outcomes between 23-gauge (23-G) vitrectomy and 20-gauge (20-G) vitrectomy for the repair of retinal detachment (RD).

Methods: A retrospective comparative analysis of 135 RD patients was conducted between January, 2013 and September, 2014 in the Ophthalmology Department of the Affiliated Hospital of Weifang Medical College. The clinical outcomes of RD patients who underwent 23-G vitrectomy (n = 65) and 20-G vitrectomy (n = 70) were compared. A logistic regression analysis was used for prognostic factors in RD patients. A meta-analysis was performed using the comprehensive Meta-Analysis version 2.0 software.

Results: Baseline characteristics of RD patients between the 23-G group and the 20-G group were not significantly different (all p>0.05). The postoperative wound closure time was obviously shorter, and postoperative intraocular pressure (IOP; mmHg) and the incidence of macular holes (MH) were evidently lower in the 23-G group than in the 20-G group (all p<0.05). However, no statistical significances in the postoperative retinal reattachment rate or visual acuity improvement in the logarithm of the minimum angle of resolution (logMAR) were detected between the 23-G group and the 20-G group (both p>0.05). The meta-analysis further confirmed a shorter postoperative wound closure time, as well as a lower postoperative IOP and incidence of MH in the 23-G group than in the 20-G group (all p<0.05), while neither the postoperative retinal reattachment rate nor the visual acuity improvement in the logMAR showed statistical significance (all p>0.05).

Conclusions: Our retrospective comparative study of RD surgery using 20-G or 23-G techniques revealed a shorter postoperative wound closure time, as well as a lower postoperative IOP and incidence of MH in the 23-G group than in the 20-G group, confirming the superiority of 23-G vitrectomy over 20-G vitrectomy. This study provided a better option of 23-G vitrectomy for clinically managing RD.

Retinal detachment (RD) is a disorder of the eye where the retina detaches away from its underlying layer of support tissue [1,2]. Initial detachment may be localized or broad, but without rapid treatment within 24–72 h, the entire retina may detach, leading to permanent vision loss and blindness, negatively affecting the life quality of patients [3,4]. RD is characterized by a subretinal accumulation of fluid underlying the retinal pigment epithelium and the neurosensory retina at the level of the photoreceptor cells [5]. Annually, approximately 10.5/100,000 adults are diagnosed with RD [6]. In comparison, RD in children is rarer, with 0.001% of all children aged between 0 to 17 years diagnosed with this condition [7]. Risk factors for RD include severe myopia, retinal tears, trauma, male gender, family history, smoking, and complications from cataract surgery [8,9]. There are several methods of treating RD, each of which depends on finding and closing the breaks that have formed in the retina, including cryopexy, laser photocoagulation, scleral buckle surgery, pneumatic retinopexy and vitrectomy [10-12].

Vitrectomy consists of transconjunctival sutureless vitrectomy, such as 23-gauge (23-G) vitrectomy, and conventional pars plana vitrectomy, such as 20-G vitrectomy [13]. The introduction of vitrectomy has offered the potential for considerable benefits to RD patients [14]. The ‘gold-standard’ for RD treatment, 20-G vitrectomy, was widely popularized in the last two decades of the 20th century [15], and 20-G instruments are versatile for a broad spectrum of vitreoretinal surgeries and for gaining access to the tissues through scleral incision or sclerotomy after conjunctival periotomy, though it requires sutures at the end of the procedure [16]. Alternatively, 23-G vitrectomy was originally reported by Hilton in 1995 as a two-sclerotomy technique and it was subsequently developed by Eckardt in 2005 as a three-way primary pars plana vitrectomy technique [17,18]. More recently, improved visual outcomes and superior anatomic benefits were reported with 23-G vitrectomy in different vitreoretinal disorders, such as RD, macular holes (MH), proliferative diabetic retinopathy, epiretinal membranes (ERM), and vitreous hemorrhage [19]. Previous published studies demonstrated the strong
advantages of 23-G vitrectomy over 20-G vitrectomy, but several other studies noted complications, such as increased incidences of postoperative hypotony, endophthalmitis, and MH, using the 23-G system [20-23]. In view of the ambiguous data from different studies regarding the comparative clinical efficacies of 23-G vitrectomy and 20-G vitrectomy in the repair of RD, we performed this study to systematically compare the clinical outcomes between 23-G vitrectomy and 20-G vitrectomy using the following parameters: wound closure time, intraocular pressure (IOP), incidence of MH, retinal reattachment rate, and visual acuity improvement, for the management of RD.

METHODS

Ethics statement: The study was approved by the ethics committee of the Affiliated Hospital of Weifang Medical College. Written informed consent was provided by each eligible patient or the patient’s next of kin and the study conformed to the Declaration of Helsinki [24].

Subjects: A retrospective comparative analysis of 135 patients who underwent vitrectomy for RD repair was conducted between January, 2013 and September, 2014 in the Ophthalmology Department of the Affiliated Hospital of Weifang Medical College. Among them, 65 patients (male, 38, female, 27; age range, 40–60 years; mean age, 50.29±5.99 years) underwent 23-G vitrectomy (23-G group); and 70 patients (male, 45, female, 25; age range, 40–64 years; mean age, 52.27±6.61 years) underwent 20-G vitrectomy (20-G group).

All patients were confirmed as having RD by a color Doppler-type ultrasonic diagnostic apparatus or CT/MRI scanning. Diagnostic criteria of RD were as follows: (1) retinoschisis, formed by cystoid degeneration and fusion, occurs under the peripheral fundus, presenting a hemispherical bulge; (2) the inner wall of the split retina is thin and transparent, and pigmentations are observed near the edge of the outer wall of the split retina; (3) the area of retinoschisis presents an absolute scotoma and is inactive, without subretinal fluid [25]. All patients had no history of retinal laser treatment, RD surgeries, or ophthalmic drug administration. The exclusion criteria were as follows: (1) patients having received vitrectomy, retinal operation, or cataract surgery; (2) patients with diabetic retinopathy; (3) patients with aphakia; (4) patients with grade C proliferative vitreoretinopathy (PVR) before the surgery; (5) patients needing silicone oil intraocular tamponade; and (6) pregnant and lactating women.

All eligible patients included in the study first had a color Doppler ultrasound examination for the diagnosis of RD, and they were then examined by the eyelid method. Before vitrectomy, with all patients in the supine position and eyes closed, eyelids and periorbital skin were scrubbed with the coupling agent, and the observation of retinal location and morphology was performed with multisction scanning of the eyeball by a high-frequency probe lying on the eyelid skin. Whether there is membranous echogenicity in the vitreous body, a relationship between the initiation site of the intraocular membrane and the optic papilla and the wall of eyeball during oculo-gyration, or movement of the eyeball were observed. Blood flow in lesions was observed by color Doppler flow imaging. If there is a blood flow signal, spectrum characteristics were analyzed.

Surgical procedures: The 23-G group underwent vitrectomy by using the 23-G trocar-cannula system (Alcon Laboratories, Inc., Fort Worth, TX). The conjunctiva and sclera were penetrated by a trocar 3.5 mm posterior to and in parallel with the limbus, depending on the lens status, at an angle between 20° and 30° with the bevel up, while inserting the cannula into the scleral incision. Once the trocar sleeve was reached, the cannula was rotated perpendicular to the eyeball toward the posterior pole. The cannula was held in place with forceps and the trocar was removed. The 20-G group underwent vitrectomy by using the standard 20-G vitrectomy system. The scleral incision was made by inserting a 20-G vitreoretinal blade. The intraoperative technologies used mainly included the stripping of membranes, intraocular diathermy, laser photocoagulation, trans-scleral cryotherapy, gas-fluid exchange, and gas/silicone oil tamponade.

Outcome measures: Baseline characteristics of all patients, including gender, age, the number of the cases of rhegmatogenous retinal detachment (RRD), the number of the cases of traction retinal detachment (TRD), and the number of the cases of traumatic RD, were recorded. All patients received a follow-up of 6 to 12 months. During the follow-up, postoperative wound closure time, postoperative IOP, postoperative incidence of MH, postoperative retinal reattachment rate, and postoperative visual acuity improvement in the logMAR were observed and recorded.

Statistical analysis: The SPSS 18.0 statistical software was used for data analysis. Measurement data were presented as mean ± standard deviation (±s). The t test was applied to compare the data between two groups, and the q test was applied to compare enumeration data. An unconditional logistic regression analysis was performed for prognostic factors in RD patients. A p<0.05 was considered statistically significant.

Computerized databases [PubMed, China National Knowledge Infrastructure (CNKI),] were used to search papers published before September 2014 that assessed 23-G vitrectomy in treating RD compared with 20-G vitrectomy.
using selected common keywords ("retinal detachment," "RD," “rhegmatogenous retinal detachment,” “PRD,” “23-gauge vitrectomy,” “23-G vitrectomy,” “20-gauge vitrectomy,” “20-G vitrectomy,” “vitreous surgery,” “ophthalmic surgery,” “efficacy,” etc.). The comprehensive Meta-Analysis version 2.0 software (CMA 2.0, Biostat Inc., Englewood, New Jersey, USA) was used to perform the statistical meta-analysis. The standard mean differences (SMD) or odds ratios (ORs) with 95% confidence intervals (CI) were calculated by applying a fixed-effects model (Mantel-Haenszel method) or a random-effects model (DerSimonian and Laird method) to evaluate the difference in clinical efficacy between 23-G vitrectomy and 20-G vitrectomy in the treatment of RD. The Z test was used to examine pooled effect size [26], and the forest plot was used to compare the SMD or OR with a 95% CI between groups.

RESULTS

Baseline characteristics: One hundred and thirty-five patients underwent vitrectomy for RD repair. Seventy patients received the 20-G system treatment, and 65 patients received the 23-G system. The baseline characteristics recorded for the patients are summarized in Table 1. No significant differences in baseline characteristics were apparent between the 23-G and 20-G groups (all p>0.05).

Clinical outcomes: Postoperative follow-up revealed the postoperative wound closure time (months) was obviously shorter, and the postoperative IOP (mmHg) and incidence of MH were evidently lower in the 23-G group than in the 20-G group (postoperative wound closure time, 3.35±1.56 months versus 9.07±2.45 months, p<0.01; postoperative IOP, 8.42±3.13 mmHg versus 12.24±3.93 mmHg, p<0.01; postoperative incidence of MH, 29.2% versus 57.1%, p = 0.039). There was no statistical significance in the postoperative retinal reattachment rate and postoperative visual acuity improvement in the logMAR between the 23-G group and the 20-G group (both p>0.05; Table 2, Table 3).

Logistic regression analysis for prognostic factors in RD patients: A dualistic logistic regression analysis was performed with the operation method in RD patients as the dependent variable, and age, gender, postoperative wound closure time, postoperative IOP, and postoperative incidence of MH were used as independent variables. The results revealed that both postoperative wound closure time and postoperative IOP were prognostic factors for RD (postoperative IOP: OR = 0.621, 95% CI = 0.434–0.890, p = 0.009; postoperative wound closure time: OR = 0.118, 95% CI = 0.032–0.434, p = 0.001; Table 4).

Comparison of clinical outcomes of 23-G and 20-G vitrectomy for RD by meta-analysis: In total, 13 clinical studies met our inclusion criteria for this meta-analysis [13,19,27-37]. A total of 3,235 RD patients were involved in this study.

<table>
<thead>
<tr>
<th>Characteristics</th>
<th>23-G vitrectomy (n=65)</th>
<th>20-G vitrectomy (n=70)</th>
<th>P</th>
<th>t</th>
<th>95%CI</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gender (Male/Female)</td>
<td>38/27</td>
<td>45/25</td>
<td>0.487</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Age (year, x± s)</td>
<td>50.29±5.99</td>
<td>52.27±6.61</td>
<td>0.071</td>
<td></td>
<td></td>
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<tr>
<td>RRD (n, %)</td>
<td>53 (81.5%)</td>
<td>56 (80.0%)</td>
<td>0.941</td>
<td></td>
<td></td>
</tr>
<tr>
<td>TRD (n, %)</td>
<td>9 (13.8%)</td>
<td>8 (11.4%)</td>
<td>0.709</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Traumatic RD (n, %)</td>
<td>3 (4.7%)</td>
<td>6 (8.6%)</td>
<td>0.389</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>


Table 1. Baseline characteristics of patients in the 23- and the 20-gauge vitrectomy groups.

<table>
<thead>
<tr>
<th>Indicators</th>
<th>23-G vitrectomy (n=65)</th>
<th>20-G vitrectomy (n=70)</th>
<th>P</th>
<th>t</th>
<th>95%CI</th>
</tr>
</thead>
<tbody>
<tr>
<td>Postoperative wound closure time (months)</td>
<td>3.35±1.56</td>
<td>9.07±2.45</td>
<td>&lt;0.001</td>
<td>16.04</td>
<td>5.015–6.425</td>
</tr>
<tr>
<td>Postoperative IOP (mmHg)</td>
<td>8.42±3.13</td>
<td>12.24±3.93</td>
<td>&lt;0.001</td>
<td>6.22</td>
<td>2.605–5.035</td>
</tr>
<tr>
<td>Postoperative visual acuity improvement in LogMAR</td>
<td>0.25±0.21</td>
<td>0.27±0.21</td>
<td>0.581</td>
<td>0.55</td>
<td>–0.052–0.092</td>
</tr>
</tbody>
</table>

23-G vitrectomy: 23-gauge vitrectomy. 20-G vitrectomy: 20-gauge vitrectomy. * compared to 23-G vitrectomy group, p<0.01; IOP: intraocular pressure. LogMAR: logarithm of the minimum angle of resolution. 95%CI: 95% confidence intervals.
meta-analysis, including 1,738 patients undergoing 23-G vitrectomy and 1,497 patients undergoing 20-G vitrectomy. Four included studies, which reported the difference in postoperative wound closure time between the 23-G group and the 20-G group, revealed the postoperative wound closure time in the 23-G group was shorter than that in the 20-G group (SMD = -1.608, 95% CI = -3.206–-0.010, p = 0.049; as seen in Figure 1A). Three included studies, which reported the difference in postoperative IOP between the 23-G group and the 20-G group, demonstrated that postoperative IOP in the 23-G group was lower than that in the 20-G group (SMD = -0.748, 95% CI = -1.478–-0.018, p = 0.045; Figure 1B). Seven included studies that compared the postoperative incidence of MH of 23-G vitrectomy and 20-G vitrectomy showed that the postoperative incidence of MH in the 23-G group was obviously lower than that in the 20-G group (OR = 0.386, 95% CI = 0.245–0.606, p<0.001; Figure 1C). Five included studies compared the retinal reattachment rate after 23-G and 20-G vitrectomy and implied no observably statistical significance of postoperative incidence of retinal reattachment between the 23-G group and the 20-G group (OR = 0.938, 95% CI = 0.366–2.404, p = 0.894; Figure 2A). Additionally, six included studies assessed the visual acuity improvement in the logMAR after 23-G and 20-G vitrectomy, and no statistical significant in the visual acuity improvement in the logMAR was detected between the 23-G group and the 20-G group (SMD = -0.066, 95% CI = -0.396–0.264, p = 0.697; Figure 2B).

**DISCUSSION**

In this present study, the clinical outcomes between 23-G vitrectomy and 20-G vitrectomy were evaluated in patients with RD, and we focused on five primary parameters after the operation, including wound closure time, IOP, incidence of MH, retinal reattachment rate, and visual acuity improvement. The validation of a new technique, here 23-G vitrectomy, in a selected indication should first refer to the capacity of obtaining at least the same rate of functional and anatomic results and an acceptable rate of adverse events when compared to the standardized technique, here 20-G vitrectomy [19]. The most important findings in our study demonstrated that 23-G vitrectomy was superior to 20-G vitrectomy in managing RD, with a shorter wound closure time, lower IOP, and lower incidence of MH in the 23-G vitrectomy group, suggesting 23-G vitrectomy is a safe and reproducible technique for the management of RD. Similarly, there is previous evidence showing 23-G vitrectomy has the advantage of accelerated wound recovery over 20-G vitrectomy: (1) in the study of Yanyali et al., the sclerotomy size in 23-G vitrectomy is just 0.6 mm compared to 0.89 mm in 20-G vitrectomy; thus, a minimally invasive wound with a protective drivepipe that can prevent the wound from damage in 23-G vitrectomy may explain the shorter wound closure time in 23-G vitrectomy [38]; (2) the 23-G vitrectomy instruments are characterized by greater stiffness and edge stability, reducing the risk of retinal impairment in vascular membrane fiber tissue segmentation, which may be another reason for the shorter wound closure time in 23-G vitrectomy.

**Table 3. Incidence of macular hole (MH) and retinal reattachment rate after 23-gauge vitrectomy and 20-gauge vitrectomy.**

<table>
<thead>
<tr>
<th>Indicators</th>
<th>23-G vitrectomy (n=65)</th>
<th>20-G vitrectomy (n=70)</th>
<th>P</th>
<th>OR</th>
<th>95%CI</th>
</tr>
</thead>
<tbody>
<tr>
<td>Postoperative incidence of MH (%)</td>
<td>19 (29.2%)</td>
<td>40 (57.1%) *</td>
<td>0.039</td>
<td>0.512</td>
<td>0.269–0.972</td>
</tr>
<tr>
<td>Postoperative retinal reattachment rate (%)</td>
<td>62 (95.4%)</td>
<td>66 (94.3%)</td>
<td>0.963</td>
<td>1.012</td>
<td>0.624–1.641</td>
</tr>
</tbody>
</table>

23-G vitrectomy: 23-gauge vitrectomy. 20-G vitrectomy: 20-gauge vitrectomy. *, compared to 23-G vitrectomy group, p<0.05; OR: odd ratios. 95%CI: 95% confidence intervals.

**Table 4. Logistic regression analysis of prognostic factors for retinal detachment.**

<table>
<thead>
<tr>
<th>Variable</th>
<th>B</th>
<th>SEM</th>
<th>Wald</th>
<th>df</th>
<th>Sig.</th>
<th>Exp (B)</th>
<th>95% CI</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age</td>
<td>-0.038</td>
<td>0.064</td>
<td>0.356</td>
<td>1</td>
<td>0.551</td>
<td>0.963</td>
<td>0.850–1.090</td>
</tr>
<tr>
<td>Gender</td>
<td>-0.245</td>
<td>0.884</td>
<td>0.077</td>
<td>1</td>
<td>0.781</td>
<td>0.782</td>
<td>0.138–4.422</td>
</tr>
<tr>
<td>Wound closure time</td>
<td>-2.135</td>
<td>0.664</td>
<td>10.345</td>
<td>1</td>
<td>0.001</td>
<td>0.118</td>
<td>0.032–0.434</td>
</tr>
<tr>
<td>Postoperative IOP</td>
<td>-0.476</td>
<td>0.183</td>
<td>6.748</td>
<td>1</td>
<td>0.009</td>
<td>0.621</td>
<td>0.434–0.890</td>
</tr>
<tr>
<td>Incidence of MH</td>
<td>-1.285</td>
<td>0.916</td>
<td>1.970</td>
<td>1</td>
<td>0.160</td>
<td>0.277</td>
<td>0.046–1.665</td>
</tr>
</tbody>
</table>

B: Regression coefficient value; SEM: standard error of the mean; Wald: Wald Chi square value. df: degrees of freedom. Sig: p value; Exp (B): adjusted odds; IOP: intraocular pressure. MH: macular hole. 95%CI: 95% confidence interval.
Consistent with our results, Sandali et al. and Pielen et al. reported that 23-G vitrectomy reduced operating time, improved patient comfort, accelerated wound healing and visual recovery, and reduced postoperative astigmatism [21,33].

In addition, Kusuhara et al. documented that in their gas-filled eyes, the mean overall IOP on postoperative day 1 was significantly lower in the 23-G group than in the 20-G group and the incidence of postoperative hypotony was 8.5% after 23-G vitrectomy and 0% after 20-G vitrectomy [21]. Previous reports suggested that transient postoperative hypotony is caused by unsutured sclerotomies [40,41]. The relatively lower postoperative IOP in the present study could be because of surgical indication. In RD cases, the extensive intraocular manipulation during the thorough removal of peripheral vitreous gel causes wound extension, thus contributing to the larger number of unsealed sclerotomies [29].

In addition, postoperative complications after small-incision, sutureless 23-G vitrectomy is rare, with a lower incidence of MH compared to 20-G vitrectomy. The reason for the lower incidence of MH in 23-G vitrectomy is unclear. One possible explanation is that the lower cutter...
efficiency of small-G cutters in 23-G vitrectomy leads to less damage to the macular area. Because the instruments are smaller, the aspiration rates are lower than those achieved with 20-G instrumentation [30]. Scartozzi et al. compared the incidence of sclerotomy-related retinal breaks between the 20-G and 23-G vitrectomy systems for macular pucker and MH, and they found a trend toward slightly lower rates of retinal breaks with the 23-G system compared with the 20-G system [42]. No observably statistical difference in the postoperative incidence of retinal reattachment or the amount of improvement in logMAR visual acuity between the 23-G group and the 20-G group was found in our current study. However, there were improvements in the visual acuity and better reattachment rates resulting from 23-G vitrectomy and 20-G vitrectomy, respectively. Koh et al. conducted a study to explore the effectiveness and safety of 23-G vitrectomy, revealing the preoperative and postoperative mean logMAR visual acuity was 0.06±0.15 and 0.54±0.31, respectively; that is, the mean logMAR visual acuity was improved by 23-G vitrectomy [43]. A study by Narayanan et al. demonstrated the primary reattachment rate was 83.3% in the 23-G group and 86.8% in 20-G group, and the visual acuity at the last visit was improved in both the 23-G and 20-G groups [33]. In conclusion, our retrospective comparative study of RD surgery using the 20-G or 23-G techniques revealed a shorter postoperative wound closure time, lower postoperative IOP, and lower incidence of MH in the 23-G group than in the 20-G group. This confirmed the superiority of 23-G vitrectomy over 20-G vitrectomy; however, it also showed the results of both techniques are not significantly different in terms of the incidence of retinal reattachment or the logMAR visual outcome. This study provided a better option of 23-G vitrectomy for clinically managing RD. However, with our own limitations, such as our inclusion and exclusion criteria of the meta-analysis, may be incomplete, which may result in the omission of relevant high-quality literature and potential complications that this present study did not assess. Further prospective studies are required to evaluate the expected increase in the quality of life after 23-G vitrectomy.

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Figure 2. Comparison of retinal reattachment rate and visual acuity improvement in the logMAR after 23-G vitrectomy and 20-G vitrectomy for RD. A: Comparison of retinal reattachment rate after 23-G vitrectomy and 20-G vitrectomy for RD in enrolled studies showed that five included studies implying no observably statistical significance of postoperative incidence of retinal reattachment between the 23-G group and the 20-G group. B: Comparison of visual acuity improvement in the logMAR after 23-G vitrectomy and 20-G vitrectomy for RD in enrolled studies showed that six included studies presenting that no statistical significant in the visual acuity improvement in the logMAR was detected between the 23-G group and the 20-G group; 23-G vitrectomy, 23-gauge vitrectomy; 20-G vitrectomy, 20-gauge vitrectomy; RD, retinal detachment; LogMAR, logarithm of the minimum.
REFERENCES


