Comparison of percutaneous balloon compression and glycerol rhizotomy for the treatment of trigeminal neuralgia

Clinical article

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Object. The aim of this study was to compare percutaneous balloon compression (PBC) and percutaneous retrogasserian glycerol rhizotomy (PRGR) in terms of effectiveness, complications, and technical aspects.

Methods. Sixty-six consecutive PBC procedures were performed in 45 patients between January 2004 and December 2008, and 120 PRGR attempts were performed in 101 patients between January 2006 and December 2008. The PRGR procedures were not completed due to technical reasons in 19 cases. Five patients in the Balloon Compression Group and 9 patients in the Glycerol Group were lost to follow-up and were excluded from the study. The medical records and the intraoperative fluoroscopic images from the remaining cases were retrospectively examined, and the follow-up was completed with telephone contact, when necessary. The 2 groups were compared in terms of initial effect, duration of effect, and rates of complications as well as severity and type of complications.

Results. The rates for immediate pain relief were 87% for patients treated with glycerol injection and 85% for patients treated with balloon compression. The 50% recurrence time was 21 months for the balloon procedure and 16 months for the glycerol procedure. When the groups were broken down by the “previous operations” criterion, the 50% recurrence time was 24 months for the Glycerol First Procedure Group, 6 months for the Balloon First Procedure Group, 8 months for the Glycerol Previous Procedures Group, and 21 months for the Balloon Previous Procedures Group. The rates of complications (excluding numbness) were 11% for PRGR and 23% for PBC, and this difference was statistically significant (chi-square test, p = 0.04).

Conclusions. Both PRGR and PBC are effective techniques for the treatment of trigeminal neuralgia, with PRGR presenting some advantages in terms of milder and fewer complications and allowing lighter anesthesia without compromise of analgesia. For these reasons the authors consider PRGR as the first option for the treatment of trigeminal neuralgia in patients who are not suitable candidates or are not willing to undergo microvascular decompression, while PBC is reserved for patients in whom the effect of PRGR has proven to be short or difficult to repeat due to cisternal fibrosis. (DOI: 10.3171/2010.1.JNS091106)

Key Words • balloon compression • glycerol injection • trigeminal neuralgia

Three decades have passed since the almost concurrent first publications of Håkanson and Mullan, the inventors of percutaneous glycerol rhizotomy and balloon compression, respectively.13,24 The literature abounds with reports on the outcomes of these 2 surgical modalities, but unfortunately the reported results are so variable and even conflicting that the relative efficacy of the methods is difficult to evaluate. Moreover, there is no publication that directly compares these techniques, although there are many studies that compare one of them with other surgical treatments. An indirect comparison can be obtained by reviewing studies that compare reports that meet certain quality criteria. In 2 recent review publications the number of selected high-quality studies on balloon compression or glycerol rhizotomy was reported to be extremely low for both therapies; thus, a relevant comparison is difficult to perform.25,28

One special feature in the therapy of TN is that the available surgical treatments range from the minimally invasive percutaneous techniques to a major intracranial operation. The choice of technique, if MVD is not an option, is often difficult for both the doctor and the patient. The need for analysis and comparison of the advantages and disadvantages of each technique is evident.

In the Neurosurgical Department of the Karolinska University Hospital, both of these techniques are included in the surgical armamentarium; the department has a long history of experience with both, especially glycerol rhizotomy, which was first established there.13 Glycerol rhizotomy is used as a first option in elderly patients and

Abbreviations used in this paper: MS = multiple sclerosis; MVD = microvascular decompression; PBC = percutaneous balloon compression; PRGR = percutaneous retrogasserian glycerol rhizotomy; TN = trigeminal neuralgia.
Balloon compression versus glycerol rhizotomy

patients unwilling to undergo MVD or in whom MVD is unsuitable. Balloon compression is regarded as a second option treatment in refractory cases previously treated with other modalities.

The aim of this study is to directly compare, recognizing the limitations of a retrospective study, PBC and glycerol rhizotomy in terms of special features, effectiveness, and complications, trying to fill the existing gap in this knowledge.

Methods

Cases

Between January 2004 and December 2008 (a 5-year period), 66 consecutive PBC procedures were performed in 45 patients. Between January 2006 and December 2008 (a 3-year period), 120 consecutive PRGRs were performed in 101 patients. In the Glycerol Group it was not possible to complete the operation for technical reasons (usually unacceptable contrast filling of the trigeminal cistern) in 19 cases (16%). Five patients in the PBC Group and 9 patients in the PRGR Group were lost to follow-up and were excluded from the study.

The medical records and the intraoperative fluoroscopic images for the patients in the remaining cases (61 in the Balloon Group and 92 in the Glycerol Group) were reviewed retrospectively. Analysis was based on the assumption that each case represents 1 surgical procedure. The follow-up was completed with telephone contacts when needed. The demographic characteristics of the 2 groups are presented in Table 1. Our department’s policy regarding the selection of technique is clearly reflected in the sample, creating a large difference in the parameter of “previous operations.” In the Glycerol Group, a large percentage of cases involved patients who did not undergo any previous surgical treatment. In the Balloon Group, in contrast, only a minority of patients were not previously treated with different surgical modalities. In the Glycerol Group, the vast majority of the previous operations were glycerol rhizotomies, while in the Balloon Group different invasive options were represented more evenly. For the above-mentioned reasons, the groups were further subdivided into 2 subgroups each: one in which the procedure was the first lesional operation that the patient had undergone (designated with the letter F for first), and one in which the patient had been previously undergone one or more lesional operations (designated with the letter P for previous).

Definitions

The groups were compared in terms of initial effect, duration of effect, rates of complications as well as severity and type of complications. An initial positive response was defined as complete pain relief within 2 weeks after the intervention. The end point of the follow-up that was used for the calculation of the duration of the effect was either the time point when the pain recurred or the time when the end point of the study was reached (December 2008), while the patient was out of medication. The duration of the effect was measured in months. The main clinical diagnoses were classic TN or similar symptoms in MS. The few patients who had bilateral neuralgia without a definite diagnosis of MS or a minor background neuropathic pain component due to previous lesional treatments in addition to the classic paroxysmal component were included in the Classic Neuralgia Group.

The Balloon Compression Procedure

The operation was performed under general intubation anesthesia with a short-acting anesthetic agent. The patient was intubated and positioned supine on the operating table. The head was stabilized by a vacuum pillow, and a local anesthetic agent was injected toward the trajectory to the foramen ovale. A C-arm fluoroscopic image intensifier was used to obtain lateral skull images. The entry point was positioned about 3 cm lateral and slightly inferior to the corner of the mouth, and a stab wound was created with a large-bore sharp needle. A Fogarty 4F (Baxter) catheter was tested for integrity and prepared so as to remove air bubbles during the balloon’s inflation with contrast. A specially designed 14-gauge needle with a blunt obturator was advanced slowly toward the foramen ovale using the external Härtel landmarks as well as the assistance of the lateral fluoroscopic images. When the needle just passed the foramen ovale, it was not further advanced, the stylet was withdrawn, and the Fogarty catheter was advanced slowly toward the foramen ovale using the external Härtel landmarks as well as the assistance of the lateral fluoroscopic images. When the needle just passed the foramen ovale, it was not further advanced, the stylet was withdrawn, and the Fogarty catheter was advanced until it protruded 17 mm from the needle’s tip. The balloon was slightly inflated with contrast (Omnipaque 300 mg iodine/mL, GE Healthcare), retracted into the Meckel cave, reinflated, and inspected for shape and position. The balloon was inflated with about 0.7 mL of contrast medium until it resembled a pear or dumbbell shape, and remained inflated for 60–120 seconds (modified according to the judgment of the surgeon). If the balloon’s shape was not satisfactory, the needle was withdrawn and repositioned. After

### Table 1: Demographic characteristics of the glycerol rhizotomy and balloon compression series

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>Glycerol Group</th>
<th>Balloon Group</th>
</tr>
</thead>
<tbody>
<tr>
<td>no. of cases</td>
<td>92</td>
<td>61</td>
</tr>
<tr>
<td>mean age in yrs</td>
<td>70 ± 14</td>
<td>70 ± 10</td>
</tr>
<tr>
<td>male/female (%)</td>
<td>37:63</td>
<td>43:57</td>
</tr>
<tr>
<td>% patients w/ MS</td>
<td>13</td>
<td>28</td>
</tr>
<tr>
<td>mean no. yrs of TN</td>
<td>11 ± 9</td>
<td>11 ± 8</td>
</tr>
<tr>
<td>involvement of trigeminal divisions (% of cases)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1st division</td>
<td>35</td>
<td>26</td>
</tr>
<tr>
<td>2nd division</td>
<td>87</td>
<td>74</td>
</tr>
<tr>
<td>3rd division</td>
<td>49</td>
<td>72</td>
</tr>
<tr>
<td>previous ops</td>
<td></td>
<td></td>
</tr>
<tr>
<td>mean no.</td>
<td>0.95 ± 1.06</td>
<td>2.77 ± 1.86</td>
</tr>
<tr>
<td>PRGR (% of cases)</td>
<td>40</td>
<td>82</td>
</tr>
<tr>
<td>PBC (% of cases)</td>
<td>2</td>
<td>33</td>
</tr>
<tr>
<td>MVD (% of cases)</td>
<td>10</td>
<td>21</td>
</tr>
<tr>
<td>Gamma Knife (% of cases)</td>
<td>9</td>
<td>11</td>
</tr>
<tr>
<td>any (% of cases)</td>
<td>55</td>
<td>92</td>
</tr>
</tbody>
</table>
compression, the balloon was deflated, and the needle and the catheter were removed simultaneously. Firm pressure was applied to the cheek for some minutes. Intraluminal pressure recordings were not used. The procedure usually required less than 20 minutes of operation time. Frontal fluoroscopy was not, as a routine, used in this series of cases.

The Glycerol Rhizotomy Procedure

The operation was performed in the surgical theater under sedation with a light intravenous anesthetic agent (usually propofol). The patient was in the sitting position in a slightly modified dentist’s chair. The head was stabilized to the pillow of the chair. A C-arm fluoroscopic image intensifier was used to obtain lateral and frontal skull images. An area on the cheek was prepared with antiseptic solution and draped, leaving the anatomical landmarks uncovered. A local anesthetic agent was infiltrated along the trajectory to the foramen ovale. The entry point was positioned about 3 cm lateral and slightly inferior to the corner of the mouth. A 22-gauge (90 × 0.7 mm; sometimes 120 × 0.7 or 120 × 0.9 mm when required) lumbar cannula was inserted through the entrance point toward the foramen ovale using the Härkel landmarks. When the needle tip had penetrated the foramen ovale, the stylet was removed and spontaneous exit of CSF was anticipated. If there was no spontaneous CSF flow, the needle was advanced slightly. At this point cisternography was performed by injecting contrast medium (iohexol, 300 mg iodine/ml) through the needle with a 1.0-ml syringe. Lateral and frontal fluoroscopic images were obtained to verify an intracisternal needle position. If the cistern was visualized adequately we continued with the procedure, otherwise the procedure was repeated after correction of the needle position. Following contrast injection, the operating chair was tilted to the supine position for 10 minutes to allow for evacuation of contrast medium from the cistern. If the evacuation was inadequate, 2 ml of normal saline was injected to wash away the remains of the contrast medium to the posterior fossa. A new lateral image was obtained to verify the evacuation of the cistern. The patient was returned to the sitting position with the head slightly flexed, and an average of 0.25 ml anhydrous sterile glycerol mixed with tantalum for permanent marking of the cistern was injected intracisternally with a 1.0-ml syringe. The patient was then transferred to a room and kept seated upright with the head slightly flexed for 1 hour.

Statistical Analysis

The Student t-test and chi-square test were used for group comparisons. The outcome was analyzed using a chi-square test for the initial response and complication rates variables. Kaplan-Meier analysis was used for the demonstration of differences regarding duration of effect. The Statistica 6 software (StatSoft, Inc.) was used.

Results

Acute Pain Relief

The rates for immediate pain relief were 87% for patients treated with glycerol injection and 85% for patients treated with balloon compression. In the Glycerol Group, 50% of patients who experienced pain relief were pain free immediately after the operation, while the other 50% responded with about 2 weeks’ delay. No late responders were identified in the Balloon Group. The medication for TN was slowly tapered with the aim of complete cessation by 1 month after the procedure.

Recurrence-Free Interval

The follow-up time for the patients who did not experience recurrent pain extended to 18 months in the Glycerol Group and 20 months in the Balloon Group. Kaplan-Meier plots were generated for both treatment modalities (Fig. 1). A separate Kaplan-Meier plot was generated to depict the differences between the subgroups (F vs P, Fig. 2).

The Kaplan-Meier plots for both groups were very similar when all the cases were considered together (Fig. 1). When the variable “previous operations” was included in the analysis, the superiority of the F Subgroups became apparent, especially in the glycerol series, whereas the difference between the F and P Subgroups almost reached statistical significance (log-rank test, p = 0.05). In the Balloon Group the difference between the F and P Subgroups did not reach statistical significance, probably because of the small number of cases (9) in the Balloon F Subgroup. According to the Kaplan-Meier plots, the 50% recurrence time (after an initial successful procedure) was 21 months for the balloon procedure and 16 months for the glycerol procedure. When the groups were stratified by the “previous operations” criterion, the 50% recurrence times were 24 months for the Glycerol F Subgroup, 6 months for the Balloon F Subgroup, 8 months for the Glycerol P Subgroup, and 21 months for the Balloon P Subgroup. The actuarial chances for each group and subgroup to obtain and maintain a pain-free outcome at 2 years posttreatment follow-up are presented in Table 2.

The Glycerol Group was characterized by more early recurrences that were most pronounced in the Glycerol F Subgroup, in which all the recurrences appeared within 24 months. In the Balloon Group the difference between the F and P Subgroups did not reach statistical significance, probably because of the small number of cases (9) in the Balloon F Subgroup. According to the Kaplan-Meier plots, the 50% recurrence time (after an initial successful procedure) was 21 months for the balloon procedure and 16 months for the glycerol procedure. When the groups were stratified by the “previous operations” criterion, the 50% recurrence times were 24 months for the Glycerol F Subgroup, 6 months for the Balloon F Subgroup, 8 months for the Glycerol P Subgroup, and 21 months for the Balloon P Subgroup. The actuarial chances for each group and subgroup to obtain and maintain a pain-free outcome at 2 years posttreatment follow-up are presented in Table 2.

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Balloon compression versus glycerol rhizotomy

Fig. 2. Kaplan-Meier plot illustrating the differences in the duration of the analgesic effect when the cases are subdivided according to the "previous operations" variable. The gradual loss of effect with repeated glycerol injections is apparent.

13 months. In the Balloon Group the recurrences were more evenly distributed throughout the follow-up period. These findings are evident in the obviously larger difference between the mean time of recurrence and the mean time of follow-up (reflecting the cases without recurrence) in the Glycerol Group (9 vs 18 months) and the Balloon Group (17 vs 20 months), respectively.

It is a well-known phenomenon that repeat glycerol procedures provide shorter durations of pain relief. To overcome this fact to achieve somewhat better comparability, we can compare the Glycerol F Subgroup with the Balloon Group as a whole (the Balloon F Subgroup was very small for comparison purposes and the balloon repeat procedures represented just a small percentage of this group). It becomes apparent from the Kaplan-Meier curve that patients who received glycerol as a first treatment fared a little better than those in the Balloon Group, especially in the long run. The 50% recurrence times were 24 months for the Glycerol F Subgroup and 17 months for the Balloon Group. The actuarial probabilities of remaining pain free at 36 months postoperatively were 47% for the Glycerol F Group and only 24% for the Balloon Group.

Complications

The rates of complications (excluding numbness) were 11% for glycerol rhizotomy and 23% for balloon compression, and this difference was statistically significant (chi-square test, p = 0.04). As shown in Table 3, in the Glycerol Group dysesthesias was the most frequent type of complication, whereas in the Balloon Group there was a greater diversity of complications, mainly dysesthesias, cranial nerve dysfunction (masseter muscle weakness, diplopia, and hearing and olfactory disturbances), and development of an arteriovenous fistula (1 case of spontaneous occlusion within a few days). The rate for corneal anesthesia was the same for both modalities and no case of anesthesia dolorosa was observed in these series. Regarding postoperative hypesthesia the figures were, not unexpectedly, considerably higher in the Balloon Group (62 vs 45%; chi-square test, p = 0.03). The rate in the Balloon Group was still higher even when the groups were compared for hypesthesia that persisted within the time boundaries of the study, but the between-groups difference was no longer statistically significant (34 vs 27%; chi-square test, p = 0.33). Many surgeons consider sensory loss a positive indicator in patients who have undergone PBC but not necessarily in those who have undergone PRGR. However, in our series the patients with postoperative hypesthesia fared better in both modalities and this was statistically significant (Cox-Mantel test, p = 0.001 and p = 0.02, respectively).

Discussion

The Therapeutic Spectrum for TN

Percutaneous retrogasserian glycerol rhizotomy and PBC stand very close to each other in the spectrum of TN treatments. At the more invasive end of this spectrum we have the only procedure that addresses a presumptive pathophysiological mechanism of TN, the microvascular decompression of a vascular conflict at the dorsal root entry zone of the trigeminal nerve (MVD). Although MVD has proven very effective, carrying a low risk in experienced hands, it is still a major intracranial operation that requires general anesthesia and may be risky for older and debilitated patients. Nowadays, it is recognized as the procedure of choice in all cases in which an intracranial operation with general anesthesia is suitable.

At the other end of the spectrum we have the percutaneous techniques, with percutaneous radiofrequency rhizotomy being the oldest and most appreciated, together with Gamma Knife radiosurgical irradiation of the trigeminal root, which is considered by many the least invasive of the interventions. Percutaneous radiofrequency rhizotomy has been associated with selectivity and good outcomes, but a relatively higher risk for the development of postoperative dysesthesias and anesthesia dolorosa—both very difficult to treat and distressing conditions. Furthermore, it requires the intraoperative cooperation of the patient for lesion localization. To address these problems, both Håkanson and Mullan introduced PRGR and PBC with great enthusiasm in the early 1980s.

Advantages and Disadvantages of PRGR and PBC

While PBC managed to gain and retain many advocates, PRGR was gradually abandoned by many surgeons

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TABLE 2: Actuarial probability of absolute pain relief 2 years posttreatment*

<table>
<thead>
<tr>
<th>Group or Subgroup</th>
<th>Probability (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Glycerol</td>
<td>38</td>
</tr>
<tr>
<td>Balloon</td>
<td>40</td>
</tr>
<tr>
<td>Glycerol F</td>
<td>51</td>
</tr>
<tr>
<td>Glycerol P</td>
<td>25</td>
</tr>
<tr>
<td>Balloon F</td>
<td>44</td>
</tr>
<tr>
<td>Balloon P</td>
<td>40</td>
</tr>
</tbody>
</table>

* F = first; P = previous.
who were confronted with disappointing results.\textsuperscript{8,19,22,27} Actually, PRGR is the therapeutic modality that has been associated with the most varying results in the literature on the treatment of TN. Linderoth and Lind\textsuperscript{22} attributed this fact to the large number of modified techniques that were used by different authors, and they proposed a state-of-the-art technique for the achievement of optimal results. There are still many surgeons who report favorable results with the PRGR technique.\textsuperscript{15,16,21,25}

One advantage of PRGR in comparison with PBC is that it is less invasive because the needle used in PRGR is much thinner and compression of anatomical structures is not required. The lesion in PRGR is based on the chemical properties of glycerol,\textsuperscript{21} whereas in PBC it is purely mechanical. Another advantage is that PRGR can be performed under local anesthesia and sedation, not requiring the short-intubation general anesthesia of PBC. The major disadvantage of PRGR is that it is technically more challenging than PBC; the experience of the surgeon can play an important roll in the outcome, an observation that is reflected in the aforementioned diverse results reported in the literature. Another disadvantage is that glycerol injection must be performed in the sitting position in a sedated patient, a fact that can be distressing for the patient and cumbersome for the surgeon and the anesthesiologist. Moving the patient to the bed and keeping him or her in an upright position for another hour also poses a problem.

### Selectivity

A major problem associated with percutaneous techniques is selectively lesioning the retrostellar rootlets of the symptomatic trigeminal division and sparing the other divisions to minimize postoperative complaints and complications. Percutaneous radiofrequency rhizotomy has been claimed to be the most branch-selective method, especially after the advent of the spring electrode, but the corneal problems still remain a limitation.\textsuperscript{26,29} Although it is impossible to achieve selectivity with balloon compression, the rates of corneal anesthesia reported in association with this technique are very low.\textsuperscript{8,19,22,23,27,28} In contrast, glycerol rhizotomy has been proposed to carry a certain degree of selectivity, achieved with slight modifications of the operative technique.\textsuperscript{2,21}

#### Outcome and Complication Rates

Effectiveness is the second component of cost-effectiveness and this is what gives meaning to the cost restriction. A therapeutic technique must, above all, be effective. The current study confirms the favorable results reported for PBC in previous studies and simultaneously questions the decision of many surgeons to abandon percutaneous glycerol injection. Regarding the durability of complete pain relief, the Kaplan-Meier plots for the modalities seem to be strikingly similar. If the “previous operations” variable is taken into consideration, a large proportion of the patients who receive glycerol rhizotomy as their first treatment experience long-lasting pain relief; the curve for the first glycerol injection is positioned higher than the curves for PBC, especially in the long-term perspective. The effect is reduced with consecutive glycerol injections, a well-known phenomenon attributed to the development of fibrosis intracisternally, which reduces the effectiveness of PRGR especially for the third branch.\textsuperscript{1,4,21} The effect of PBC on pain does not seem to be influenced by previous glycerol injections, and this permits a shift to PBC without loss of effect when repeated glycerol injections become ineffective (K Kouzounias et al., unpublished data).

The complication rates were much lower for PRGR, and complications were generally much milder, consisting mainly of sensation disturbances. The use of PBC carries with it a relatively high frequency of marked hypesthesia and also some rarer side effects such as masseter weakness and diplopia, which usually regress spontaneously after a few weeks (see Table 3).\textsuperscript{3} The advantages of PRGR are considered to include the low rate of postoperative hypesthesia, as was originally proposed by Håkanson.\textsuperscript{13} As expected, the rates of postoperative hypesthesia in our series were significantly lower in the Glycerol Group than in the Balloon Group, but certainly not negligible.

#### Choice of Therapy

Our department’s policy is to offer MVD to younger (<70 years of age), healthy individuals with TN as the first treatment option. Glycerol rhizotomy is offered as a first option for elderly or weak patients, patients with MS (who often suffer from major side effects of pharmacotherapy even at modest doses\textsuperscript{26}), patients not willing to undergo an intracranial operation, and patients with recurrent TN after MVD—especially with negative findings. Balloon compression is usually offered as a second option for patients who experience rapid recurrence of pain after a technically successful glycerol rhizotomy. Radiofrequency rhizotomy is reserved, in our center, for TN that persists after treatment with all the above modalities and is localized in the third division. Finally, Gamma Knife irradiation is offered as a first option when the patient selects this minimally invasive technique, needs heavy

### Table 3: Complication rates and postoperative hypesthesia in detail\textsuperscript{*}

<table>
<thead>
<tr>
<th>Complications</th>
<th>Glycerol Group</th>
<th>Balloon Group</th>
</tr>
</thead>
<tbody>
<tr>
<td>complications other than hypesthesia (%)</td>
<td>11</td>
<td>23</td>
</tr>
<tr>
<td>dysesthesia</td>
<td>8</td>
<td>5</td>
</tr>
<tr>
<td>diplopia</td>
<td>1</td>
<td>7</td>
</tr>
<tr>
<td>masseter weakness</td>
<td>0</td>
<td>7</td>
</tr>
<tr>
<td>corneal anesthesia-keratitis</td>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td>herpes eruption</td>
<td>5</td>
<td>7</td>
</tr>
<tr>
<td>AV fistula</td>
<td>0</td>
<td>3 (1 case)</td>
</tr>
<tr>
<td>hearing-olfactory</td>
<td>0</td>
<td>5</td>
</tr>
<tr>
<td>anesthesia dolorosa</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>hypesthesia (%)</td>
<td>45</td>
<td>62</td>
</tr>
<tr>
<td>persistent hypesthesia (%)</td>
<td>27</td>
<td>34</td>
</tr>
</tbody>
</table>

\textsuperscript{*} Values represent percentage of cases in which the given complication(s) occurred. Abbreviation: AV = arteriovenous.
Balloon compression versus glycerol rhizotomy

anticoagulant therapy, or other techniques have failed. Both PRGR and the Gamma Knife were developed at the Karolinska, the latter first targeting the Gasserian ganglion. In our hands at the Karolinska, the PRGR has been the procedure that has been easiest on the patients out of the group of percutaneous procedures producing an immediate effect. The Gamma Knife procedure has been used in our center primarily for patients with problems of bleeding diathesis, very advanced age, or concurrent disease as well as for those who request this procedure. It has been regarded as a major disadvantage of this method that the latency for the full effect might be as long as 6 weeks, and several patients scheduled for a Gamma Knife procedure have been treated with PRGR due to the need for immediate pain relief.

Limitations

Because our study was retrospective and not a prospective, randomized, controlled study we do not claim that it represents a true, valid comparison with mathematical criteria. However, we feel that some useful conclusions can be extracted despite this limitation and especially in the context of a lack of any other comparison between these 2 methods in the literature.

Conclusions

Because one single technique to address this difficult problem—a technique that will be effective in the long run, minimally invasive, and cost-effective at the same time—has not yet been invented, we are obliged to optimally use the existing techniques, each with its advantages and limitations. The effectiveness of PBC is confirmed in this study. Furthermore, it has been shown that PRGR, when applied correctly, can also achieve good results with a lower complication rate. We believe that the minimal invasiveness and the satisfying results in experienced hands justify proposing PRGR as the first option for the treatment of TN in patients not fit for MVD, followed by PBC when PRGR fails or no longer offers pain alleviation to the patient.

Disclosure

The authors report no conflict of interest concerning the materials or methods used in this study or the findings specified in this paper.

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