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Videoangiography : Simple Technique to "Resuscitate" Partially
Occluded Bridging Veins During Microneurosurgical Operations

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"Squeeze Maneuver" Assisted by Indocyanine Green Videoangiography: Simple Technique to "Resuscitate" Partially Occluded Bridging Veins During Microneurosurgical Operations

Joham Choque-Velasquez¹, Roberto Colasanti^{1,2}, Behnam Rezai Jahromi¹, Juha Hernesniemi¹

■ **OBJECTIVE:** The preservation of normal peri/intralesional bridging veins is extremely important in every microneurosurgical operation. The purpose of our study was to describe the "squeeze maneuver" assisted by indocyanine green videoangiography (ICGV), a simple technique to "resuscitate" partially occluded bridging veins during microneurosurgical operations.

■ **METHODS:** When a bridging vein is inadvertently stretched up to its collapse during microneurosurgical procedures, a precise identification of the partially occluded zone is carried out under high magnification (10–15×), as well as with the aid of the ICGV. If a continuous irrigation with isotonic saline solution does not allow one to reestablish the venous flow, the "squeeze maneuver" is carried out. This consists of squeezing and sliding with the bipolar forceps the occluded vessel along the normal venous flow direction. This procedure is repeated several times, while a continuous saline irrigation is applied. The ICGV is performed to confirm an adequate patency of the vein.

■ **RESULTS:** This maneuver permits to restore the normal diameter of the vein and blood flow inside it.

■ **CONCLUSION:** The "squeeze maneuver" assisted by ICGV represents a safe, clean, fast, and even cheap method for restoring the flow of partially occluded bridging veins during microneurosurgical operations.

INTRODUCTION

The preservation of normal peri/intralesional bridging veins is extremely important in every microneurosurgical operation. Their protection may require extensive high precision and careful work, but this is essential to achieve an optimal result. Indeed, venous occlusion may result in significant postoperative complications such as brain edema, regional or diffuse brain swelling, hemorrhagic infarction, and, sometimes, even death due to uncontrollable intracranial hypertension. Hence preservation of bridging veins, whenever possible, is paramount.¹⁻³

"Simple, clean, fast, and preserving normal anatomy" describes the "squeeze maneuver" assisted by indocyanine green videoangiography (ICGV) that follows our general philosophy of microneurosurgery.^{4,5} Indeed, this maneuver, available to be used in hundreds of patients each year at our institution, represents a simple technique to "resuscitate" partially occluded bridging veins during microneurosurgical operations.

SQUEEZE MANEUVER ASSISTED BY ICGV

This technique does not need special equipment; the basic set includes the usual microsurgical instruments, specifically bipolar regular stainless steel forceps with sharp tips (0.3 mm), a suction tube (with 3 holes at its base that enable controlling the suction force by sliding the thumb), a handheld syringe for focused saline irrigation, Surgicel Fibrillar strips (Ethicon Inc., Johnson & Johnson, Neuchatel, Switzerland) with papaverine, and hemostatic agents such as TachoSil (Takeda Austria GmbH, Linz, Austria) or Gelfoam (Pfizer, New York, New York, USA) (Figure 1).

Key words

- Bridging vein
- High magnification
- Indocyanine green videoangiography
- Microneurosurgery
- Squeeze maneuver
- Surgical techniques
- Venous flow restoration

Abbreviations and Acronyms

ICGV: Indocyanine green videoangiography

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Figure 1. Our basic set for microneurosurgery.

During microsurgical procedures, especially to deep-seated lesions, even if brain retraction is minimized, bridging veins may be inadvertently stretched up to their collapse.

In such troublesome circumstances the following steps should be performed:

1. A precise identification of the partially occluded zone of the vein is carried out under the microscope at high, routinely used magnification that is routinely used (10–15 $\times$), as well as with the aid of the ICGV.
2. The partially occluded vein area is continuously irrigated with isotonic saline solution in order to rehydrate it up to restore the elasticity of the vascular tissue, as well as the normal diameter of the vessel. This may reestablish the venous flow in many cases (see Illustrative Case 1).
3. Sometimes, even if the collapsed vein, which has been stretched for quite a while, is profusely irrigated with saline solution, only a delicate squeeze maneuver will reestablish venous flow. In these cases, bipolar forceps with sharp tips (0.3 mm) are used, squeezing and sliding simultaneously the occluded vessel along the normal venous flow direction. This

Figure 2. (A–C) Preoperative magnetic resonance imaging (MRI) revealing a left-sided intra-axial frontal lesion. (D–F) Postoperative MRI confirming gross total resection of the

tumor without evidence of surrounding hemorrhage or ischemia, as well as the restoration of the blood flow inside the frontal bridging vein (G, H).

Figure 3. (A) Intraoperative microscopic photograph showing the collapse of a frontal bridging vein. (B) Initial indocyanine green videoangiography (ICGV) confirming

the absence of flow inside the vein (arrow). (C, D) ICGV illustrating the restoration of the normal venous flow after continuous saline irrigation.

procedure is repeated several times, while a continuous saline irrigation is applied to restore the normal diameter of the vein and the blood flow inside it (see Illustrative Case 2).

4. The ICGV is performed to confirm an adequate patency of the vein.
5. If some persisting stenosis area is revealed, Surgicel strips soaked in papaverine are applied in order to promote vasodilation. The vessel patency is again assessed through ICGV at the end of the surgical operation.

ILLUSTRATIVE CASES

Illustrative Case 1

A 36-year-old woman underwent resection of a deep left frontal glioma. During the interhemispheric approach, a frontal bridging vein was stretched up to its collapse. A continuous saline irrigation over the collapsed vein was needed to restore normal venous flow (Figures 2 and 3) (see Video, Supplemental Digital Content 1, demonstrating the restoration of the normal venous flow by a continuous irrigation with isotonic saline solution). The patient consented to submission of this case to the journal.

Illustrative Case 2

A 30-year-old woman underwent resection of a left ruptured paracallosal arteriovenous malformation. During the interhemispheric approach a frontal bridging vein was stretched up to its

collapse, which was confirmed by ICGV. Even though the occluded vein was profusely irrigated by saline solution, only a delicate squeeze maneuver reestablished venous flow (Figures 4 and 5) (see Video, Supplemental Digital Content 2, illustrating the squeeze maneuver assisted by indocyanine green videoangiography to restore the normal venous flow of a collapsed frontal bridging vein). The patient consented to submission of this case to the journal.

DISCUSSION

Bridging veins preservation in microneurosurgery should be always attempted, whenever possible, as their sacrifice may determine postoperative complications if an adequate collateral venous drainage is absent.

First of all, force and duration of brain retraction should be minimized. This may be reached by the following: 1) accurate preoperative planning; 2) correct patient positioning; 3) adequate bone removal for skull base approaches in order to widen the working area; 4) execution of atraumatic "cisternal" approaches, along arachnoidal pathways, which provide excellent brain relaxation while minimizing cerebral retraction and possible neurovascular complications.^{1,4-13}

Nonetheless, sometimes bridging veins may limit the operative window. Because of this risk, several techniques for preserving venous flow have been reported as follows.

Video available at
WORLDNEUROSURGERY.org

Figure 4. (A–D) Preoperative radiologic images revealing a left ruptured paracallosal arteriovenous malformation. (E–H) Postoperative radiologic images showing the resection of the arteriovenous

malformation without evidence of surrounding ischemia. (I) Postoperative angiographic study confirming the restoration of a normal blood flow inside the frontal bridging vein.

Sugita et al² suggested dissecting free the vein from the cortical surface for a length of 10–20 mm, on the basis of the needed brain retraction. Koperna et al¹⁴ proposed a method for preserving the vein of Labbé by dissecting it out of its dural bed and displacing its fixation point to the dura. Kyoshima et al³ described a dura-reflecting technique to preserve bridging veins in the frontotemporal and subtemporal approaches.

When the integrity of the vein wall is damaged, on the basis of the size of the defect, methods for definitive repair include wrapping, microsuture, venous reconstruction using the silicone tubing technique or saphenous vein bypass graft, and vein anastomosis.^{1,15–20} However, all of these procedures are not

useful for collapsed veins with uninjured walls. In these circumstances, a profuse irrigation with isotonic saline solution may be useful to rehydrate the vein wall in order to restore its normal diameter.

If this is not sufficient, the delicate squeeze maneuver may be useful. Indeed, the graduated and antegrade compressions along the normal venous flow direction counteract the venous stasis so as to create a pressure gradient that allows the restoration of blood flow into the vein.

The high magnification of the operating microscope (10–15×) is clearly helpful to identify the exact zone of partial occlusion of a small bridging vein.^{21,22}

Figure 5. (A) Intraoperative microscopic photograph showing the collapse of a frontal bridging vein. (B) Initial indocyanine green videoangiography confirming

the absence of flow inside the vein (arrow). (C) A continuous "squeeze maneuver" progressively restored a normal flow inside the vein (D).

Moreover, ICGV may represent a remarkable intraoperative tool for a real-time assessment of the patency of the collapsed vein while the restoration of the blood flow is attempted.²³⁻²⁵

The illustrative cases depict the squeeze maneuver during an interhemispheric approach. Nonetheless, this technique can be used to restore the flow of bridging veins that are encountered through different routes.

A potential hazard for the squeeze maneuver is represented by an inappropriate/excessive compression of the vein wall that may injury it, as well as promote thrombotic mechanisms.

Only constant training under high magnification allows one to develop the microsurgical skills and manual dexterity that are required to master this technique with care and precision.²⁶

In our experience, a correct indication for use of the squeeze maneuver (i.e., partially occluded bridging veins during microneurosurgical operations) was not so frequent, about 5–6 cases/year. In these circumstances, such technique always allowed us to safely restore the normal diameter of the vein and the blood

flow inside it. If a persisting stenosis area was revealed, Surgical strips soaked in papaverine were applied in order to promote vasodilation. Intraoperative ICGV, as well as postoperative radiologic controls, confirmed the vessel patency in all the cases. Moreover, when the squeeze maneuver was employed, no postoperative related clinical complication, such as hemorrhage or ischemia, was detected.

On the other hand, when the partially occluded vein is cortical and it is not recovering with the squeeze maneuver, anastomosis using a short saphenous or artificial vein bypass graft may be attempted.¹⁹

CONCLUSION

In summary, the squeeze maneuver assisted by ICGV may represent a safe, clean, fast, and even cheap method for restoring the flow of partially occluded bridging veins during microneurosurgical operations. Hence we believe that this relatively simple technique, borne out by years of experience, should be an useful adjunct in the neurosurgical armamentarium.

REFERENCES

1. Sindou M, ed. *Practical Handbook of Neurosurgery*. Vienna, Austria: Springer Vienna; 2009.
2. Sugita K, Kobayashi S, Yokoo A. Preservation of large bridging veins during brain retraction. Technical note. *J Neurosurg*. 1982;57:856-858.
3. Kyoshima K, Oikawa S, Kobayashi S. Preservation of large bridging veins of the cranial base: technical note. *Neurosurgery*. 2001;48:447-449.
4. Hernesniemi J, Niemelä M, Karatas A, Kivipelto L, Ishii K, Rinne J, et al. Some collected principles of microneurosurgery: simple and fast, while preserving normal anatomy: a review. *Surg Neurol*. 2005;64:195-200.
5. Velasquez JC, Lau J, Kozyrev D, Sharafeddin F, Colasanti R, Luostarinen T, et al. Clean, fast and preserving normal anatomy: "the Helsinki revolution" in microneurosurgery. *J Neurosurg Sci*. 2016; 60:44-53.
6. Yaşargil MG. A legacy of microneurosurgery: memoirs, lessons, and axioms. *Neurosurgery*. 1999; 45:1025-1092.

7. Yaşargil MG. Personal considerations on the history of microneurosurgery. *J Neurosurg.* 2010;112:1163-1175.
8. Hernesniemi J, Niemelä M, Dashti R, Karatos A, Kivipelto L, Ishii K, et al. Principles of microneurosurgery for safe and fast surgery. *Surg Technol Int.* 2006;15:305-310.
9. Yasargil MG. *Microneurosurgery: Microsurgical Anatomy of the Basal Cisterns and Vessels of the Brain, Diagnostic Studies, General Operative Techniques and Pathological Considerations of the Intracranial Aneurysms.* New York, NY: Thieme; 1984.
10. Yasargil MG. *Microneurosurgery, Vol. 2: Clinical Considerations, Surgery of the Intracranial Aneurysms and Results.* New York, NY: Thieme; 1984.
11. Yasargil MG. *Microneurosurgery III-B: AVM of the Brain, Clinical Considerations, General and Special Operative Techniques, Surgical Results.* New York, NY: Thieme; 1988.
12. Yasargil M. *Microneurosurgery: CNS Tumors—Surgical Anatomy, Neuropathology, Neuroradiology, Neurophysiology, Clinical Considerations, Operability, Treatment Options v. 4A.* New York, NY: Thieme; 1993.
13. Yasargil MG. *Microneurosurgery, Volume IVB: Microneurosurgery of CNS Tumors.* New York, NY: Thieme; 1996.
14. Koperna T, Tschabitscher M, Knosp E. The termination of the vein of “Labbé” and its microsurgical significance. *Acta Neurochir (Wien).* 1992;118:172-175.
15. Sakaki T, Morimoto T, Takemura K, Miyamoto S, Kyo K, Utsumi S. Reconstruction of cerebral cortical veins using silicone tubing. Technical note. *J Neurosurg.* 1987;66:471-473.
16. Morimoto T, Inoue M, Okumura Y, Tsuzuki T, Sakaki T. Cerebral cortical venous reconstruction using saphenous vein graft. *J Clin Neurosci.* 1997;4:357-360.
17. Mery FJ, Amin-Hanjani S, Charbel FT. Cerebral revascularization using cadaveric vein grafts. *Surg Neurol.* 2009;72:362-368 [discussion: 368].
18. Nussbaum ES, Defillo A, Janjua T, Nussbaum LA. Microvascular repair of an injured cortical draining vein. *Surg Neurol.* 2009;72:530-531.
19. Morita A, Sekhar LN. Reconstruction of the vein of Labbé by using a short saphenous vein bypass graft. Technical note. *J Neurosurg.* 1998;89:671-675.
20. Murata J, Sawamura Y, Saito H, Abe H. Resection of a recurrent parasagittal meningioma with cortical vein anastomosis: technical note. *Surg Neurol.* 1997;48:592-595 [discussion: 595-597].
21. Yaşargil MG. Intracranial microsurgery. *Proc R Soc Med.* 1972;65:15-16.
22. Matsumura N, Shibata T, Hori E, Kamiyama H, Tami M, Okamoto S, et al. An operating microscope with higher magnification and higher resolution for cerebral aneurysm surgery: preliminary experience-technical note. *Neurol Med Chir (Tokyo).* 2014;54:497-501.
23. Dashti R, Laakso A, Niemelä M, Porras M, Hernesniemi J. Microscope integrated indocyanine green video-angiography in cerebrovascular surgery. *Acta Neurochir Suppl.* 2011;109:247-250.
24. Gruber A, Dorfer C, Standhardt H, Bavinski G, Knosp E. Prospective comparison of intraoperative vascular monitoring technologies during cerebral aneurysm surgery. *Neurosurgery.* 2011;68:657-673 [discussion: 673].
25. Dashti R, Hernesniemi J. Intraoperative assessment of a quality of microneurosurgical clipping: role of indocyanine green videoangiography. *World Neurosurg.* 2014;82:e589-590.
26. Kivilev J, Hernesniemi J. Four-fold benefit of wound closure under high magnification. *Surg Neurol Int.* 2013;4:115.

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Jim Bean, MD. “Serpentine garden wall between the West Lawn and West Range at the University of Virginia, Charlottesville, Virginia. Serpentine design by Thomas Jefferson to add stability to the single layer brick wall, without need for buttress supports.”