Surgical Neurology International

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Original Article

Four-fold benefit of wound closure under high magnification

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Received: 03 April 13 Accepted: 29 July 13 Published: 13 September 13

This article may be cited as:
Kivelev J, Hernesniemi J. Four-fold benefit of wound closure under high magnification. Surg Neurol Int 2013;4:115.
Available FREE in open access from: http://www.surgicalneurologyint.com/text.asp?2013/4/1/115/118171

Abstract

Background: Unaffected wound healing and good cosmetic result after a neurosurgical procedure are important factors measuring a level of care. The usefulness of high magnification of the operating microscope during closure of neurosurgical wounds is evaluated.

Methods: During a one-year microneurosurgical fellowship, the first author (JK) performed wound closure under the microscope in 200 of 524 neurosurgical operations carried out by the senior author (JH) at the Department of Neurosurgery, Helsinki University Central Hospital. Supratentorial approaches were employed most frequently in 143 patients (72%). Surgeries for infratentorial lesions and the spinal canal comprised 48 (24%) and 9 procedures (4%), respectively. Mean duration of the surgery from skin to skin was 1.8 (range 0.5-6.2) hours. After intradural hemostasis was completed by the senior author, further steps including dural suturing, bone flap fixation, and wound closure were performed by the first author. Wound condition was assessed during the early and late postoperative period. Mean follow-up was 3.2 (range 1-10) months.

Results: Early postoperative healing of the wound was uneventful in 180 patients (90%). No wound rupture or postoperative hematoma occurred. In five patients (2.5%), lumbar puncture or spinal drainage was necessary due to significant subcutaneous liquor collection. No wound revision was required. At follow-up, in 196 patients (98%) the postoperative scar was in perfect condition. Neither skin necrosis nor healing problems occurred.

Conclusion: Based on our results, we found the high magnification of operating microscope to be beneficial when closing neurosurgical wounds; it allows (1) better hemostasis, (2) precise wound margin approximation, (3) atraumatic handling of the tissues, and (4) improvement of the manual dexterity of the neurosurgeon.

Key Words: High magnification, manual dexterity, neurosurgical wound

Access this article online
Website:
www.surgicalneurologyint.com
DOI:
10.4103/2152-7806.118171
Quick Response Code:

INTRODUCTION

In the late 1960s, Professor M.G. Yazargil established the fundamental principles of microneurosurgery. His ideas, experience, and legacy were collected in four volumes of "Microneurosurgery," followed by numerous papers.[23] Neurosurgery has since become one of the most highly developed medical specialties. Advances in operating microscope facilities and improved microsurgical techniques have allowed very delicate procedures to be performed safely through small openings and limited spaces.[12,20]

Improvement of manual skills is one of the most important aspects of training. Practice of wound closure under the operating microscope is very useful for young neurosurgeons to improve their dexterity, a view shared by the senior author (JH) since the 1980s.[9,13,19] While laboratory training is essential to gain microneurosurgical experience, the relaxing, static environment is not comparable with that of the operating room, where stress of the actual surgery imposes entirely different demands on the surgeon.[11] In this study, we retrospectively analyzed our experience in using an operating microscope during wound closure to evaluate its usefulness in neurosurgical training.

MATERIALS AND METHODS

Patients

During a one-year microneurosurgical fellowship (September 1, 2011–September 1, 2012) the first author (JK) assisted in 200 of the 524 neurosurgical operations performed by the senior author (JH) at the Department of Neurosurgery, Helsinki University Central Hospital (the list of other fellows assisting in the remaining 324 procedures is presented in Table 1). There were 142 scheduled procedures (71%) and 58 emergencies (29%). The most frequent operation was in the supratentorial compartment, performed on 143 patients (72%). Surgeries for infratentorial lesions and the spinal canal comprised 48 (24%) and 9 procedures (4%), respectively. The distribution of the pathologies is presented in Table 2.

The mean age of patients in the series was 54 (range 0.2-87) years. The mean age of men and women was similar. Operations in women were almost twice as frequent as in men: 126 (63%) vs. 74 (37%). Patients who underwent emergency operation were slightly younger than those who were operated on electively (mean age 50 vs. 55 years). The mean age of patients with the supratentorial procedure was 57 years, whereas the mean age of patients operated on in the infratentorial and spinal compartments was 46 and 43 years, respectively. Time of the procedure depended on the complexity of the pathology. Mean duration of surgery from skin to skin was 1.8 (range 0.5-6.2) hours. Table 2 presents the mean duration of surgery according to pathology.

Recraniotomy using the same opening and surgical corridor was performed on 22 patients (11%). Redo operations were performed in highly selected cases, occurring in 20 of the 22 patients (91%). Significant differences emerged between compartments where the redo surgeries were performed; for supratentorial lesions, redo operations were performed in 11 of 143 cases (8%), for infratentorial lesions, in 8 of 48 cases (17%), and for spinal lesions, in 3 of 9 cases (33%) ($P = 0.02$).

Table 1: A list of international fellows performing wound closure during September 1, 2011-September 1, 2012

Essam Abdelhameed
Ahmed Elsharkawy
Amit Chakrabarty
Ali Harati
Ferzat Hijazy
Serge Marbacher
Oliver Mollier
Masaki Morishige
Rafael Neira
Rossy Peña
Jouke S. van Popta
Rossana Romani
Tetsuaki Sugimoto

Table 2: Mean time of procedure

Diagnosis	Mean time of surgery, hours (range)
Anterior circulation aneurysm	1.5 (1.0-5.2)
Posterior circulation aneurysm	1.8 (1.2-3.0)
Meningeoma other than skull base	1.9 (1.3-3.3)
Skull base meningeoma	2.7 (1.1-6.2)
Intraaxial tumor	1.6 (1.0-3.1)
AVM	2.5 (1.12-5.12)
Cavernoma	1.9 (1.2-2.43)
Spinal cord intradural lesion	2.4 (1.1-5.1)
Spinal cord extradural lesion	3.3 (1.1-5.8)
Intraventricular tumor	1.5 (1.3-1.9)
Intracranial hematomas	1.2 (1.1-1.3)
Spinal spondylosis (1 case)	0.5
Pineal region lesion	1.8 (1.4-3.2)
Craniopharyngeoma	1.9 (1.7-2.2)
Encephalocele (1 case)	1.4

AVM: Arteriovenous malformation

Surgical technique

Positioning, skin incision, and intracranial procedure were performed according to the Helsinki Neurosurgical Department standards, as described elsewhere.[16] In contrast to traditional opening with stepwise incision of different skin layers, in our practice, the incision was performed through all layers simultaneously. After intradural hemostasis was completed by the senior author, further steps including dural suturing, bone flap fixation, and wound closure were performed by the first author [Figure 1]. The mean time of closure was 18 (range 11-30) minutes. In all cases, an operating microscope (Opmi® Pentero™, Carl Zeiss GmbH) was used until the last skin suture. All steps of wound

Figure 1: Wound closure under high magnification improves neurosurgeon's dexterity. Fluent cooperation with scrub-nurse is one of the most important factors making the procedure fast and effective

closure are presented in the supplemented video. Wound drainage was not used in any of the 200 procedures.

Cranial dura closure

Dural closure was performed under high magnification (10-15×) in a continuous fashion with a resorbable filament (Safil 4-0). Dural defects were covered with sealing substances, including Tachosil® pieces and Tissel Duo Quick® fibrin glue. All, even the smallest, dural vessel bleedings were controlled by bipolar coagulation. This was performed mostly after dural suturing since coagulation usually caused some additional shrinkage of the dura. For tack-up suturing, we used the holes in the craniotomy edges (made during opening) for the same thread as used when performing dural closure in a continuous manner. With such techniques, the dura was raised against the bony flap and craniotomy edges, thus diminishing the risk of epidural hematomas. Additionally, it allowed avoidance of missed injuries to underlying vessels what may happen when applying separate tack-up sutures after the dura is already closed. High magnification is of great importance at this stage since it allows the location of needle bites through the dura to be optimized and provides a precise estimation of filament integrity and tension.

Continuous irrigation while closing the dura was abandoned at our department 30 years ago. Instead, at the final stage of dural suturing, we insert the blunt needle through the small gap between its margins and fill the subdural space with saline to remove the air and ensure adequate intradural hemostasis. After this, the gap is covered by Tachosil® and/or sealed with Tissel Duo Quick® fibrin glue.

Spinal dura closure

The dura in the spine was usually closed with AnastoClips® and very rarely with a running suture. AnastoClips® proved to be much better option in the narrow and deep space of the spinal canal. It was faster and more effective than conventional suturing. The distance between AnastoClips® did not exceed 2-3 mm, which provided watertight closure. Use of high magnification of the microscope at this stage excluded any nerve root damage and allowed good approximation of the incision margins.

Bone flap fixation

To fix the bone flap, we used only the CranioFix® titanium clamp system, which appeared to be very practical. Since most of the craniotomies were not large (less than 4 × 4 cm), two clamps were sufficient to provide appropriate fixation. For better cosmesis, one of the clamps (bigger) was placed over the burr hole, covering it completely. We did not use central stay suture for epidural hematoma prevention due to the small craniotomy size and good hemostasis during dural closure. When available, we put some bone fillings collected during trephination into the burr hole to intensify ossification.

Muscle suturing

Muscles were sutured with interrupted resorbable take-off filaments (Vicryl 2-0 or 1-0). In spinal cases, muscles were sutured only after laminectomies, while after unilateral hemilaminectomies this was usually unnecessary, except for prolonged openings, when stitches were inserted through interspinal ligaments ("brother in low" suture). Special attention was paid to muscle hemostasis. This was emphasized after laminectomies due to the risk of epidural hematoma. Hemostasis was provided under high magnification, allowing a very clean operating view and precise approximation of the muscle and its fascia.

Galea and subcutis closure in the cranium

We sutured the galea and subcutis simultaneously using a running suture with a resorbable filament (Vicryl 3-0). The main goal at this stage was stable galea closure and good approximation of skin margins. The operating microscope was critical here, allowing meticulous hemostasis with bipolar. Applying a running suture in galea closure provided a strong and reliable primary knot. Furthermore, when dealing with longer incisions we added an additional single suture to the middle section of the incision to prevent rupture of the longer filament.

Aponeurosis and subcutis closure in the spine

Reliable suturing of aponeurosis in spinal cases was performed with interrupted sutures with thick resorbable filament (Vicryl 1-0 take-off needles). We did not use running suture for this layer due to the higher risks of thread rupture after mobilization of the patient. The longitudinal distance between needle bites was up to 5 mm, which provided a good approximation of aponeurotic margins. After aponeurosis closure, we closed the subcutis with a running suture using thinner resorbable filaments (Vicryl 3-0). Filament integrity and knot preservation were considered important, especially after lumbar spine approaches, due to extensive movement-related local strain.

Skin closure

Most of the primary skin incisions after lateral supraorbital or pterional approaches were closed with running resorbable intracutaneous suture (Monocryl 4-0). Use of high magnification when applying intracutaneous suture helped markedly to provide accurate approximation of the skin margins. Other cranial locations and frontal recraniotomies were closed with skin staples. The distance between staples was 4-5 mm. In some redo cases, we put staples even more frequently to ensure uneventful wound healing. In these cases, staples were removed later than usually. In small children, intracutaneous closure was performed in any primary cranial procedure. In the spine, we usually closed the skin with a running nonresorbable monofilament suture (Dafilon 3-0 or Ethilon 3-0).

Data analysis

Wound status was estimated by the first author (JK) after surgery and patients' files were retrospectively analyzed. Wound condition was assessed during two periods: The early and late postoperative period. The early postoperative period included time of hospitalization, discharge, and 2-3 weeks after surgery. The late postoperative period included follow-up in an outpatient clinic, which occurred on average 3.2 (range 1.5-10) months postoperatively. Statistical analysis including univariate (Pearson's χ^2 test) and multivariate analysis was provided using SPSS software for Windows, version 19.0 (SPSS, Inc., Chicago, IL). Univariate analysis included the following variables: Age, sex, diagnosis, surgical approach, type of admission, and location of pathology with relation to characteristics of wound healing in early and late postoperative period. After identifying risk factors in univariate analysis, variables were modified accordingly and reassessed by binary logistic regression with early and late postoperative outcome dichotomized as a dependent variable. The level of significance was set at $P < 0.05$.

RESULTS

Early postoperative period

Early postoperative healing of the wound was uneventful in 180 patients (90%). No wound rupture occurred. On the postoperative computed tomography (CT) scan after all intracranial procedures, neither subdural nor epidural expansive hematomas were revealed at the craniotomy site. None of the spinal procedures caused postoperative hematomas.

None of the patients in the series suffered from cerebrospinal fluid (CSF) leakage from the wound. In 11 patients (5.5%), nonsignificant subcutaneous CSF collection appeared, which was fully resolved by applying compression bandage in 10 persons before discharge and in one person within two weeks of surgery. Due to significant subcutaneous CSF collection in five patients (2.5%), lumbar puncture or spinal drainage was performed. None of these patients experienced any complications from lumbar puncture and were discharged after subcutaneous CSF collection resolved.

In two patients with a large olfactory meningeoma destroying the bone and infiltrating the ethmoid sinus, the package of the bony defect was performed with combined "bone-fascia" patch, and spinal lumbar drainage was applied to prevent CSF leakage. The bone patch was formed by longitudinal dividing of the craniotomy flap with an oscillating saw, and the fascia patch was harvested from the fascia lata. Both patients experienced some minor nasal SCF leakage 1-2 days postoperatively, which resolved fully before discharge. Two patients had superficial local wound bacterial inflammation, which was successfully treated by administration of oral antibiotics. One patient experienced disturbing and limiting eye opening subcutaneous hematoma after supraorbital lateral craniotomy; this, however, resolved soon after discharge. In some patients, subcutaneous local edema in the fronto-orbital region also appeared, but it was not disturbing, and thus, not considered a complication. In one case, an additional single stitch was applied on the day after surgery due to local hemorrhage from the wound. To simplify statistical analysis, we dichotomized wound healing results into two groups: Uneventful (180 patients) and others (20 patients). After univariate analysis, we found that the only approach was related to early wound healing problems ($P = 0.004$); none of the other factors was statistically significant. Next, we assessed the results with binary logistic regression using a new set of variables to confirm their statistical independence. For appropriate estimation of the results, we subdivided approaches into four groups: (1) Fronto-temporal, (2) Suboccipital medial or paramedian, (3) Double craniotomy in one session, and (4) Other approaches. This division was based on the fact that in groups 1-3, some wound problems occurred in more than 10% of patients, and in group 4 they appeared much more rarely. According to multivariate analysis [Table 3], the only factor that was independently correlated with some wound problems was double craniotomy through the same skin opening performed during the same session ($P = 0.03$). The risk of having some wound problems after such a surgery was as high as 4.7 compared with other approaches. Double craniotomy was performed on four patients; three of them were operated on for multiple intracranial aneurysms using a combination of interhemispheric and lateral supraorbital approaches during the same session, and one patient was reoperated because of a large cervical chordoma regrowth using anterior and posterior approaches under the same anesthesia. In two of these patients, extensive subcutaneous

CSF collection was found, requiring spinal drainage or wound revision with duroplasty. Another patient from this group had a small subcutaneous CSF collection that was treated successfully with compression dressings. Only one of four patients did not experience any wound problems.

Late postoperative period

At follow-up, the postoperative scar was in perfect condition in 196 patients (98%). Neither skin necrosis nor healing problems occurred. None of the patients developed severe infection requiring re-opening and wound revision. In four patients (2%), the wound had signs of superficial infection, which was successfully controlled with oral antibiotics. Only one of these patients had some wound problem in the early postoperative period (small SLC treated conservatively). When assessed with univariate and multivariate analyses, none of the preoperative factors appeared to be significantly correlated with wound problems at follow-up.

DISCUSSION

Wound closure under a high magnification of operating microscope (10-15×) improves the skills of the neurosurgeon. Based on our experience, it is associated with a minimal risk of wound complications. Even when complications occur, most are nonsignificant and resolve rapidly. At our clinic, the reasons for using an operating microscope during wound closure include good visualization of the operating field due to high magnification and illumination provided by the microscope; improved safety of all manipulations on the dura when close to the venous sinuses, dural venous lacunes, underlying bridging veins, or cortex surface; control of bleeding and achievement of precise hemostasis in all layers of the wound; more accurate approximation of wound edges, atraumatic handling of tissues and improvement of manual dexterity and instrument manipulation abilities.

Table 3: Multivariate analysis of early results using appropriate set of variables

Variable	Relative risk	*P* value
Age	0.082	0.774
Sex	0.053	0.818
Men vs. women	0.629	0.453
Kind of admission	-	1.000
Emergency vs. elective	-	1.000
Compartment	0.222	0.638
Supratentorial vs. infratentorial	0.134	0.714
Supratentorial vs. spinal	2.169	0.141
Number of surgeries	-	0.990
Duration of surgery	0.64	0.800
Duration of follow-up	-	0.998
Diagnosis*	4.7	0,030
Approach**		
Fronto-temporal vs. others		
Suboccipital (para) median vs. others		
Double vs. others		

*Each diagnosis was analyzed separately and none achieved statistical significance. **All approaches were divided into four groups according to higher complication risk addressed in univariate analysis (>10%): 1. Fronto-temporal, 2. Suboccipital para (median), 3. Double opening, and 4. Other approaches used in surgeries

Operating microscope

Modern microscopes give a crystal-like clear picture, high magnification, and very intensive illumination. They are equipped with video screens allowing neurosurgeons to know the degree of magnification while performing different steps of the procedure. The most comfortable magnification might be measured and analyzed. In our practice, gradual increase of magnification from the low (3-5×) to the highest (15×) when closing the wound has occurred reflecting the learning curve in microneurosurgical training. Good microsurgical technique supported by appropriate use of an operating microscope may provide significant time-savings during neurosurgical procedure.[11] We think that one of the main factors of more speedy manipulations under the microscope is using the mouth switch, enabling hands-free movement of counterbalanced optics in horizontal and vertical dimensions [Figure 2]. Fine adjustments of focus distance and visual field are performed without discontinuation of suturing, making the procedure faster. In our practice, the mean time of wound closure from dura till skin was only 18 minutes.

In framework of social healthcare system, cost-effective organization of surgical suite is crucial especially in big patient-volume hospitals. Minimizing the time of surgery while keeping the quality of the procedure high is one of the powerful factors that allows significant cost savings and increase of surgical activity. In the late 1990s, such approach at our department was one of the factors that made possible the double increase of annual amount of surgeries only within 3 years.[16]

Figure 2: Using of mouth switch enables hands-free movement of counterbalanced optics which speeds up the procedure

The advantages of wound closure under the operating microscope can be described within the framework of the "four better" paradigm: (1) better hemostasis, (2) better incision margin approximation, (3) better tissue handling, and (4) better manual dexterity.

Better hemostasis

No major hemorrhagic complications emerged in our patients when the wound was closed under the microscope. We did not use wound drainage in any case because we could achieve reliable hemostasis in every location of the approach and did not proceed to the next wound layer until bleeding was controlled. Using of high magnification allowed precise identification and targeted coagulation of hemorrhagic vessels. Furthermore, the microscope helped to distinguish nonsignificant venous bleeding from small arterial hemorrhage. This might be important in terms of prevention of local microcirculatory problems, which may occur when using "blind" coagulation of the bleeding site in the wound wall during closure with the naked eye.

Postoperative epidural hematoma in the early phase of the neurosurgery was very common, occurring in up to 25% of all cases.[8] In 1932, Walter Dandy first introduced dural suspension sutures, which changed the situation totally, with reports on postoperative epidural hematomas virtually disappearing from the neurosurgical literature.[8,22] In the modern era of microneurosurgery, the rate of postoperative epidural hematomas requiring evacuation varies from 0% to 2.3%.[4,10,22,24] The most recent survey on this topic was published in 1999 by Winston, who prospectively analyzed outcomes after 369 craniotomies and found no postoperative epidural hematomas at the site of craniotomy.[22] Interestingly, Winston applied tack-up sutures to only 9% of patients; in the others, it was considered unnecessary, and, still, no cases of epidural hematomas occurred.[22] In our practice, we routinely use tack-up sutures to hold the dura against the bone, but this does not negate the need for meticulous hemostasis of all dural vessels with bipolar coagulation. Use of high magnification at this stage allows very reliable control of bleeding, which in many cases may even exclude the need for tack-up sutures, especially when the bone flap is small. The risk of postoperative spinal epidural hematoma is estimated to be 0.1-2%.[2,15,17,21] Risk factors for spinal epidural hematoma include inadequate hemostasis before closure of the skin, multilevel procedures, aged more than 60 years, redo operations, preoperative coagulopathy, liver and autoimmune disease, heparinization after surgery, and arterial hypotension during closure.[1,2,14,21] In our consecutive series, no epidural hematomas appeared after spinal cases confirming that precise hemostasis with bipolar coagulation during all stages of the surgery, which can be achieved under high magnification with good illumination, is the key to avoid hemorrhagic complications.

According to our philosophy, drainage is unnecessary in most neurosurgical procedures. The rare exceptions are huge openings during decompressing craniectomies in acute trauma cases. In other instances, drainage has very limited value and might even be dangerous, with paradoxical appearance of expansive epidural hematomas after catheter withdrawal.[5,18] The mechanism of such complications may be the injury of subcutaneous arterial branches while inserting the drain with only temporary hemostasis by local catheter compression and rehemorrhage after its removal. If intensive enough, the hemorrhage spreads through the burr hole into the intracranial epidural space, causing hematoma even when tack-up sutures are preliminarily applied.[18] In spinal cases, a similar situation might occur with muscle arteries. In general, our series shows that meticulous hemostasis can be achieved using an operating microscope, suggesting that routine use of wound drains be avoided.

Better incision margin approximation

All layers of a neurosurgical wound should be restored accurately and reliably, but special attention is usually paid to the deepest (dura) and the most superficial (skin) tissues. Dural suturing is critical since it secures the brain and spinal cord surface and isolates more superficial tissues from the CSF. When needed, we always use artificial dural patches and sealants to achieve watertight closure of the dura. Most probably, the tradition of such an approach to dural closure in neurosurgery was started by Henry Cushing, who already in 1908 stated that dura should always be "painstakingly" closed.[7] Thereafter, generations of neurosurgeons were taught to perform watertight dural suturing and if not achievable then to use different sealants and other means.[3] In contrast to this paradigm, some recent studies have shown that an adaptive dural closure after craniotomies may represent a safe and cost-effective alternative to watertight dural closure.[3] Our results confirmed the effectiveness of appropriate dural closure under the microscope since none of our patients experienced CSF leakage from the wound after surgery. One explanation for this is that the degree of approximation of tissue margins can be controlled much better under high magnification than with the naked eye.

Nowadays, for many patients good cosmetic results after a neurosurgical procedure are considered an important parameter when measuring level of care.[6] Taking this into account, we pay much attention to skin closure. In anterior approaches located close to the hairline (in vast majority of cases – lateral supraorbital approach), we prefer intradermal resorbable sutures, which are usually cosmetically more advantageous and decrease discomfort of patients while preserving good wound healing [Figure 3]. When closing the skin under high magnification (10-15×), we can achieve meticulous approximation of the margins, enabling good healing in

Figure 3: Intradermal suture 4 days after surgery

most patients. Furthermore, better visualization during closure results in a significantly faster procedure. When intradermal suture is not an option (e.g., redo cases) we close the wound with staples, focusing on good approximation of the skin margins, which in most cases produces a good cosmetic result. In the literature, some neurosurgeons report that use of tissue adhesives when closing skin layers provides a better and faster option than staples, intradermal absorbable filaments, or traditional skin sutures.[6] To date, we have no experience with skin adhesive usage. Future studies will show the effectiveness of this method.

Better tissue handling

High magnification of the operating microscope allows atraumatic handling of tissues when closing neurosurgical wound. Unnecessary damages to any layer of the wound are avoided since neurosurgeons can precisely control the degree of tissue manipulation. This is of big importance when operating on redo cases after cytostatic therapy or/and local irradiation when superficial tissues are fragile and healing may be significantly impaired. Furthermore, in bypass-surgery, much attention should be paid to very careful tissue handling when closing the wound in order to avoid bypass-vessel's damage, compression, or distortion.

Better manual dexterity

Microsurgical skill can be improved only with repetitive training. For young neurosurgeons, closure under the operating microscope gives an invaluable opportunity to improve their dexterity. We are strongly convinced that the static conditions of the laboratory cannot substitute for active training of manual skills in the dynamic setting of the operating room. Learning microsurgical techniques on animals are not easily available everywhere and living human's wound closure using microscope provides excellent opportunity to improve manual skills of young surgeons. While closing under the microscope, the neurosurgeon can sharpen all his/her movements when dealing with different kinds of instruments. He/she can adjust the microscope settings according to his/her own preferences gradually increasing the magnification. As to our experience, closing under high magnification of 10-15× becomes comfortable within several months of everyday practice. The surgeon can also adopt the most appropriate and ergonomic position in relation to the microscope optics and the patient's head. With increasing number of cases one will be familiar with all basic patient positions including supine, prone, park-bench, and sitting position. In the laboratory, training of this aspect is rarely achievable, especially when considering the sitting position. At the same time, learning of the appropriate surgeon's posture is of big importance since it might affect the duration of surgery due to additional fatigue from no ergonomic movements. Extensive repetitions allow delicate movements to become automatic.[11] These improved skills will be beneficial when performing the main part of the surgery and dealing with the lesion.

CONCLUSION

Unaffected wound healing and good cosmetic result after a neurosurgical procedure are important factors measuring a level of care. Based on over 30 years' clinical experience, we showed the benefits of using an operating microscope during wound closure since the complication rate was very low. High magnification of the microscope allowed meticulous hemostasis. Wound draining was unnecessary in all patients, and no clinically relevant postoperative hematomas occurred. We recommend that young neurosurgeons use the operating microscope since it helps to perform safe and reliable wound closure and improves manual skills.

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