The Journal of International Advanced Otology

J Int Adv Otol 2017; 13(2): 186–90 • DOI: 10.5152/iao.2017.3585

Original Article

Complications of the Middle Cranial Fossa Approach for Acoustic Neuroma Removal

Matthias Scheich, Christian Ginzkey, Desiree Ehrmann-Müller, Wafaa Shehata-Dieler, Rudolf Hagen

Department of Otorhinolaryngology, Plastic, Aesthetic and Reconstructive Head and Neck Surgery, University Hospital of Wuerzburg, Wuerzburg, Germany (MS, DEM, WSD, RH)
Department of Otorhinolaryngology, University Hospital of Rostock, Rostock, Germany (CG)

Cite this article as: Scheich M, Ginzkey C, Ehrmann-Müller D, Shehata-Dieler W, Hagen R. Complications of the Middle Cranial Fossa Approach for Acoustic Neuroma Removal. J Int Adv Otol 2017; 13: 186-90.

OBJECTIVE: To analyze postoperative complications after microsurgery for acoustic neuroma (AN) via the middle fossa approach (MFA).

MATERIALS and METHODS: In total, 203 consecutive patients of a tertiary skull base referral center at a university hospital were included in this retrospective chart and database analysis. All patients had undergone primary microsurgery at the Otorhinolaryngology department via MFA between December 2005 and October 2014. Postoperative complications were documented during the inpatient stay and outpatient follow-up.

RESULTS: Overall, 41 complications were registered in 35 patients. The most common was cerebrospinal fluid (CSF) leakage in 13% of the patients. Bleeding complications were documented in seven patients: two cerebellar bleedings, one subdural and one epidural hematoma, two hematomas of the skin, and one bleeding through the closed wound. Two patients experienced meningitis and one patient had a transient ischemic attack. Furthermore, three cases of deep vein thrombosis occurred, which led to a lethal pulmonary embolism in one case. One patient sustained temporary palsy of the vocal fold and another reported antibiotic-associated diarrhea.

CONCLUSION: Acoustic neuroma surgery via the MFA can be conducted with low morbidity and mortality. The most common complication is CSF leakage, which can be treated in most cases in a stepwise conservative manner. Severe adverse events that may require revision surgery are very scarce (1%).

KEYWORDS: Complications, acoustic neuroma, vestibular schwannoma, microsurgery, middle cranial fossa approach

INTRODUCTION

Acoustic neuromas (ANs) are benign tumors of the vestibular nerve, which typically originate in the inner ear canal. They are slow growing neoplasms associated with considerable morbidity resulting in typical symptoms, such as unilateral hearing loss, tinnitus, and vertigo. According to Stangerup et al. [1], the annual incidence is about two of 100,000. Better quality and increased availability of magnetic resonance imaging technology have led to early and more often incidental discovery of small ANs [1].

Established treatment options include microsurgery, radiotherapy, or wait-and-scan protocols. All three options are known to have advantages in selected cases. Particularly, microsurgery via the middle fossa approach (MFA) has been proven to have excellent functional results in small ANs, which has been published by us and several other groups before [2-5]. When considering microsurgery, the patient must be briefed regarding the chances of hearing preservation and facial nerve preservation and regarding possible complications or adverse events. Besides the typical mild complications, there are also rare but very threatening complications. Exact data on the possible complications of this often-used approach do not exist in literature.

MATERIALS and METHODS

Patients

In this retrospective study, we included the data of 203 consecutive patients who were operated on via MFA for small (intracanalicular +/– extrameatal part) ANs between December 2005 and October 2014. Patients with recurrent or residual tumor after prior treatment as well as those with neurofibromatosis (NF2) were excluded. All complications were analyzed regarding onset and duration

Presented in: This study was presented at the 7th International Conference on Acoustic Neuroma, 12-15 April 2015, Shanghai, China.

Corresponding Address: Matthias Scheich E-mail: scheich_m@ukw.de

Submitted: 27.01.2017 • **Accepted:** 09.06.2017

©Copyright 2017 by The European Academy of Otology and Neurotology and The Politzer Society - Available online at www.advancedotology.org

during hospital stay as well as during outpatient follow-up. The minimal follow-up period from surgery was 12 months. We distinguished between complications that were directly related to the surgical procedure of tumor removal via MFA (e.g., CSF leak, intracranial bleeding) and nonrelated complications that can occur with any type of surgery. The study was approved by the local ethics committee. Due to the retrospective design of the study, informed consent was not necessary.

Middle Fossa Approach

All the microsurgeries in this series were performed using the technique originally described by House [6] and modified by Fisch [7] and Brackmann et al. [8]. After incision of the skin in a gently curving fashion from pretragal to temporal, an inferiorly based temporalis muscle flap is prepared. The temporal bone is exposed superior to the zygomatic root. A craniotomy window with a dimension of 3×4 cm is placed two-thirds anterior and one-third posterior to the outer ear canal using a cutting bur. Pressure from the CSF is relieved using mannitol application. The dura is dissected from the petrous bone, and a blunt Fisch dura retractor is placed to elevate the temporal lobe. After identifying the important landmarks (greater superficial petrosal nerve, arcuate eminence, superior petrosal sinus, and superior semicircular canal), the roof of the internal auditory canal is drilled off to incise the intrameatal dura. In most cases, we perform a noncontact tumor debulking with a carbon-dioxide (CO_2) laser (Omniguide Inc., Cambridge, MA, USA) [9] before the sharp resection of the tumor capsule. The IAC is plugged thoroughly with a temporalis muscle graft in combination with fibrin glue. Open temporal bone cells need to be covered with bone wax or fibrin patches before removing the retractor. The piece of temporal bone and the muscle flap are replaced and a suction drain is placed subcutaneously. The skin is sutured in a continuous manner and a soft pressure dressing is applied.

Statistic Analysis

All statistical analyses were performed using Statistical Package for Social Sciences (IBM Corp.; Armonk, NY, USA). Pearson's chi-squared test was used to analyze the influence of risk factors on complications. P values <0.05 were considered statistically significant.

RESULTS

Complications

In total, 41 complications occurred in 35 patients, with one patient sustaining three complications. The calculated complication rate and a relative risk of sustaining any kind of postoperative complication was found to be 17% and 20%, respectively. We found 35 complications that were directly related to the surgical procedure as well as six nonrelated complications. There were no persisting sequels except for one case of death after a pulmonary embolism (PE) event.

Patients

We included 96 men and 107 women aged 14-78 years (mean, 52 years; standard deviation, 11.7). In total, 88 tumors were categorized as stage T1 (intracanalicular) and 114 were stage T2 (extrameatal part without contact to the brainstem). The mean period from first symptoms (e.g., tinnitus, hearing disorders, and vertigo) to surgery was 27 months. Mean tumor volume was 205 mm^3 (range, 4-1350 mm^3). The subgroup of patients that experienced complications consisted of 15 men and 20 women aged from 23 to 78 years (mean, 50 years). The tumor stage was 14×T1 and 21×T2, with a mean tumor volume of 215 mm^3 (range, 38-824 mm^3).

Hospital Stay

The mean duration of hospital stay after surgery for patients without complications was 8.0 days (hospital discharge between days 5 and 14 after surgery). The patients sustaining complications were discharged at an average of 3.2 days later (range, 7-42 days).

Cerebrospinal Fluid Leakage

The occurrence of postoperative CSF leaks was noted in 26 (12.8%) of 203 patients. One patient presented with leakage through the sutured wound into the suction drainage. In the remaining 25 patients, CSF presented as (posterior) rhinorrhea through the eustachian tube. The onset of CSF leakage was between day 1 and day 7 after surgery.

Initial therapy of CSF leakage was conservative. The leakage through the wound could be stopped by removing the drainage and applying a pressure dressing. All patients with CSF leaks were treated with bed rest, elevation of the head, and intravenous (IV) antibiotics. In 69% of the cases, CSF was self-limiting after 1-67 days (median, 4 days). In one case of intermittent leakage within 67 days, the patient had refused to undergo revision surgery. Five patients needed invasive treatment. They received lumbar spinal drainage (LSD) six times for 1-4 days (onset days 1,2,3,3, and 4). Only three patients (1%) had to undergo revision surgery for persisting CSF leakage.

Hemorrhage

A total of seven patients experienced hemorrhage. There was one case of cerebellar bleeding (day 3), one hematoma of the cerebellopontine angle (CPA) (day 3), one epidural hematoma (day 9), one subdural hematoma of the contralateral side (day 3), two hematomas of the scalp (both day 3), and one bleeding of the sutured wound (postoperative day 1). The patient with the subdural hematoma (Figure 1a) required a neurosurgical craniotomy. The other bleedings were managed conservatively . The bleeding of the wound and the hematomas of the flap were treated successfully with pressure dressings. The case of cerebellar bleeding was an incidental finding on day 3 in an asymptomatic patient. The patient with the noncompressive hematoma of the CPA presented with pyramidal signs on day 3 (Figure 1b). In both cases, conservative management and watchful waiting were adequate. One patient presented at another hospital complaining of strong headaches on day 9. They excluded meningitis but found a

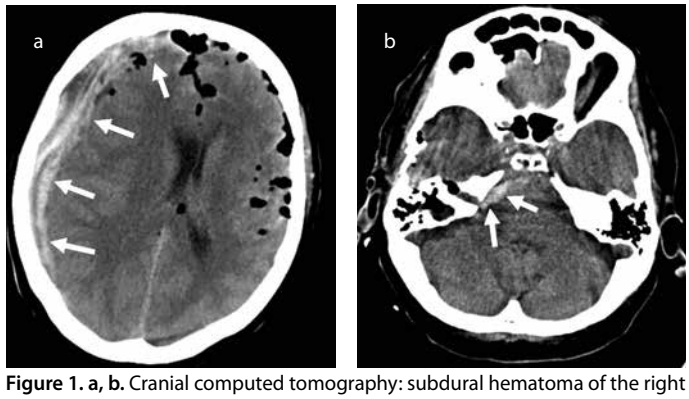

Figure 1. a, b. Cranial computed tomography: subdural hematoma of the right side (a), hematoma of the right cerebellopontine angle (b) (Dpt. of Neuroradiology, University Hospital of Würzburg, Germany; Chair: Prof. Dr. M. Pham).

noncompressive epidural hematoma of 2×0.5 cm, which did not require any further intervention.

Meningitis

Meningitis is a complication that is typically related to neurosurgical interventions. There was one case of slight meningitis on day 5. The patient presented with fever, confusion, and headache but no neck stiffness. Lumbar puncture revealed increased cells (40/mm^3). The other patient presented with typical signs of meningitis on day 20, and we identified 6,800 cells/mm^3 via lumbar puncture. Prolonged triple IV antibiotics led to restitution in both patients. We did not observe CSF leakage in either case at the time of meningitis.

Unrelated Complications

One case of vocal cord palsy of the contralateral side was documented on day 5. This patient received speech therapy for hoarseness. Five months after surgery, the palsy was no longer present.

One patient complained of loss of sensibility and motion of the contralateral hand on the first postoperative day that spontaneously recovered within 30 min. Immediate neurological examination including cranial computed tomography led to the diagnosis of a transient ischemic attack (TIA) event. Conservative management (including antibiotics and anticoagulation) was initiated. There were no further events in follow-up.

Three patients suffered from a deep venous thrombosis (DVT) despite correct anticoagulation (days 1, 1, and 3, respectively). DVT led to a massive lethal PE event in one case. The other two patients were treated with heparin and warfarin. A postoperative analysis of the coagulation status revealed one case of a prior unknown thrombophilia and another case of a therapy-associated factor XIII deficiency that had already been substituted several times during the hospital stay.

One patient sustained severe diarrhea caused by pseudomembranous colitis on day 12 during postoperative rehabilitation. Stool testing confirmed *Clostridium difficile* bacteria as well as *C. difficile* toxin. The patient received metronidazole for 10 days and bowel discomfort stopped completely after 2 days of treatment. The stool examination after antibiotic treatment was negative for both bacteria and toxins.

Risk Factors for Complications

To determine the influence of risk factors on complications, we correlated them to tumor characteristics, gender, and age. For better statistical analysis, age was dichotomized into two groups: ≤51 years (n=105; 23 complications) versus >51 years (n=98; 12 complications). Even if there were more complications in the younger patients, it did not reach statistical significance (p=0.07). There was also no significant influence of tumor dimensions on complications regarding T-stage (p=0.81), tumor volume (>150 mm^3; p=0.40), or tumor length (>10 mm; p=0.55). Furthermore, we could not prove significant differences in correlation to gender (p=0.41) or side (p=0.34).

DISCUSSION

Cerebrospinal Fluid Leakage

Postoperative CSF leakage is a characteristic complication after microsurgery for AN, which occurred in our series in 13% of the cases. It typically presents as posterior rhinorrhea via the eustachian tube or as direct incisional leakage. Becker et al. [10] as well as several other groups also found it to be the most common complication regardless of the approach. The incidence of CSF leaking after surgery via MFA is specified to be between 4% and 19% [2, 3, 10-15].

Further sequels of a CSF fistula can be avoided by an early stepwise management [16] of CSF leakage after microsurgery. This includes a pressure dressing, elevation of the head, and bed rest in combination with IV antibiotics immediately when a CSF leak is suspected. Forced Valsalva's maneuver and increased abdominal pressure (e.g., for bowel movement) should be avoided. Some authors have also recommended restriction of fluids or the prescription of acetazolamide [17]. If strict conservative treatment fails, early insertion of a LSD should be considered. Revision surgery is only necessary if LSD is unsuccessful or if the CSF leakage is very intense and has already led to signs of CSF deficiency. Surgical intervention for persisting CSF leaks is rare and reported to be between 0%-2% [3, 10, 13, 15]. In our series, re-exploration was only needed in three patients. One patient had to undergo transmastoidal revision surgery on day 12. Another patient was subjected to re-exploration via MFA on day 62 as well as via a transmastoidal approach on day 93 to finally resolve intermittent leakage. The third patient needed transmastoidal revision surgery on day 11. The revision surgery always included IV antibiotics and LSD for 3-5 additional days. In all three cases, hearing could be preserved at the preoperative level.

Hemorrhage

Secondary hemorrhage of the sutured wound or hematomas in the operation field are both typical complications after all types of surgical interventions. They are usually easy to treat, also in AN surgery. One case of bleeding at the incision site as well as two hematomas of the scalp and flap were successfully treated with pressure dressings in our patients. Evidently, one has to be extremely cautious not to push the bleeding intracranially or to dislocate the bony flap by applying the pressure dressing. Small interventions, such as overstitching the incision or relieving a hematoma and placing a drainage, are only needed in rare cases, and can usually be performed under local anesthesia. Larger hematomas should be removed under general anesthesia. This provides better options for coagulation or ligature at the origin of bleeding.

Intracranial hemorrhage occurs in 0.4%-2% of MFA cases [5, 14, 18] and can present as sub- or epidural bleeding as well as bleeding of the cerebellum or brainstem. Despite this low number, intracranial bleedings are the most common cause of death after AN surgery as reported for all approaches and all tumor sizes [5, 14, 19]. These bleedings are often caused by direct damage to vessels in the field of surgery. Intraoperative drainage of bleeding into contralateral spaces or into deeper subdural spaces can also lead to complications. Intracranial hemorrhage can be promoted by the loss of CSF. Extensive CSF loss can stretch subdural veins to the extent that they may rupture. This should be considered particularly in elderly patients in whom the dura is more fragile. The hematoma of the CPA occurred in the oldest patient in our group (age, 78 years). However, the other (asymptomatic) cerebellar bleeding developed in a 23-year-old woman. Surgery for intracranial bleeding is necessary if intracranial pressure rises or if it compresses the brain tissue. Only one patient needed

a neurosurgical craniotomy to remove a subdural hematoma of the contralateral side on day 3. The same patient unfortunately had to undergo neurosurgical revision surgery due to a hematoma of the contralateral approach on day 5 as well.

Meningitis

One case of slight meningitis occurred in a patient who had previously reported a hematoma of the scalp (which needed no further intervention). Another bacterial meningitis occurred 13 days after discharge. Postoperative meningitis after AN surgery can be either aseptic or bacterial. It is reported to be the second most common complication after AN surgery and occurs in 1%-7% of the cases [3, 5, 10, 12-14]. Most cases of postoperative meningitis are aseptic and caused by irritation of the meninges by blood, bone dust, or foreign materials. Bacterial meningitis can occur by ascension of germs, which can be promoted by CSF leakage. No CSF leak was present in either patient with meningitis at the time of diagnosis. Both types of meningitis are typically treated with prolonged IV antibiotics, which can be stopped or modified upon receipt of the culture results from the lumbar puncture.

Unrelated Complications

Vocal Cord Palsy

The cause of the vocal cord palsy of the contralateral side that recovered spontaneously within 5 months remains unclear. In 1988, Tos [20] also described one case of palsy of the vagus nerve after VS surgery without further discussing the possible causes. This palsy occurred after removal of one larger (5 cm) tumor in a series of 300 AN that were operated on via the translabyrinthine approach. Injury of lower cranial nerves can occur after surgery for larger AN in 5.5% of the cases [21]. However, these patients typically present with swallowing disorders, inability to protect the airway, and aspiration pneumonia. Since our patient did not show any defects of the other caudal cranial nerves and since we had excluded a hematoma of the brainstem, we suggest that the palsy was more likely to be idiopathic or caused by tracheal intubation trauma. Temporary vocal cord palsy can occur after endotracheal intubation in 0.04%-1.4% of surgeries [22] and is known to have a good prognosis.

Transient Ischemic Attack

The course of a 45-year-old patient who was reported with TIA on the first postoperative day cannot be directly explained by the AN surgery. The incidence of TIA in the general population is 0.07%-0.5% [23]. Typical risk factors, such as hypertension, smoking, diabetes, or advanced age, could not be identified in this patient. Another possible cause is changes in blood pressure; however, documentation during surgery and during the first postoperative night did not show any relevant alterations in blood pressure.

Deep Venous Thrombosis

The incidence of DVT in the general population is about 0.1%. The risk increases in hospitalized patients to 1.3% for DVT and 0.4% for PE [24]; however, there are major differences depending on the medical comorbidities and the cause of hospitalization (e.g., surgery). We found three cases of DVT (1.5%) and one consecutive case of (lethal) PE (0.5%). Most AN surgery series via MFA have particular cases of DVT, leading to a DVT rate of 1%-2% [3, 11, 13, 15, 25]. Minovi et al. [18] also reported on one case (1.1%) of lethal PE after DVT in a series of 89 AN patients operated on via MFA. There is a comparable rate of PE in further series with mixed approaches of 0.2%-1.1% [14, 19-21, 25-27].

The occurrence of a DVT or a PE is primarily a result of misfortune and fate. The risk of DVT after intracranial surgery is noted to be 15%-45% without prophylaxis [28]. It can be lowered to 6% by application of heparin [29]. Without prophylaxis, such patients are at risk of sustaining a PE of 1.4%-5% [28, 30, 31]. Exact guidelines exist for prophylaxis of DVT.

According to these guidelines, AN surgery is classified in the mid-risk group for DVT, and it is recommended to perform both medical prophylaxis (low molecular weight heparin) in combination with basic prophylaxis (early mobilization, physical therapy, compression bandages, and counseling).

All three patients with DVT had received correct prophylaxis according to the guidelines. The patient with the lethal course sustained PE after DVT on the afternoon of the first postoperative day. She was monitored routinely during the first night in the intensive care unit and discharged to the otorhinolaryngology ward with normal vital signs on the next morning. During further mobilization, she collapsed and died despite sudden resuscitation.

Pseudomembranous Colitis

The use of systemic antibiotics, particularly penicillin, can cause the normal bacterial flora of the gut to be over-run by *C. difficile*. This may lead to typical antibiotic-associated diarrhea. The incidence of this disease in Germany is estimated to be 5-20/100,000 [32]. It typically occurs within 4 weeks after antibiotic treatment. As for all of our VS patients, this patient had received IV ceftriaxone 2 g preoperatively until the third postoperative day. Since she was hospitalized for postoperative rehabilitation in another hospital, the complication was noted and successfully treated with metronidazole according to current guidelines [33]. If patients present with nonsevere *C. difficile* infection they may even recover rapidly without treatment [33]. Since most patients are discharged home and may not report postoperative diarrhea in follow-up, the incidence in our group may be even higher.

CONCLUSION

Microsurgery for small acoustic neuromas via the middle cranial fossa approach is an established method that is associated with a low complication rate. Cerebrospinal fluid leakage is a common complication (13%) that can be managed conservatively in most cases. Severe complications, which may lead to revision surgery, are rare (1%). Persisting sequels of these complications are uncommon and occur in less than 1% cases. Patients must receive adequate information not only regarding the very satisfying functional results of this method, but also concerning such possible complications to make a better decision before choosing this kind of therapy.

Ethics Committee Approval: Ethics committee approval was received for this study from the ethics committee of the University of Würzburg, Germany.

Informed Consent: Due to the retrospective design of the study, informed consent was not necessary.

Peer-review: Externally peer-reviewed.

Author Contributions: Concept - M.S., C.G.; Design - M.S.; Supervision - R.H.; Materials - M.S.; Data Collection and/or Processing - M.S., C.G., D.E.M.; Analysis and/or Interpretation - M.S.; Literature Search - M.S.; Writing Manuscript - M.S.; Critical Review - W.S.D., R.H.

Conflict of Interest: No conflict of interest was declared by the authors.

Financial Disclosure: The authors declared that this study has received no financial support.

REFERENCES

1. Stangerup SE, Tos M, Thomsen J, Caye-Thomasen P. True incidence of vestibular schwannoma? Neurosurgery 2010; 67: 1335-40. [CrossRef]
2. Ansari SF, Terry C, Cohen-Gadol AA. Surgery for vestibular schwannomas: a systematic review of complications by approach. Neurosurg Focus 2012; 33: E14. [CrossRef]
3. Arts HA, Telian SA, El-Kashlan H, Thompson BG. Hearing preservation and facial nerve outcomes in vestibular schwannoma surgery: results using the middle cranial fossa approach. Otol Neurotol 2006; 27: 234-41. [CrossRef]
4. Ginzkey C, Scheich M, Harnisch W, Bonn V, Ehrmann-Müller D, Shehata-Dieler W, et al. Outcome on hearing and facial nerve function in microsurgical treatment of small vestibular schwannoma via the middle cranial fossa approach. Eur Arch Otorhinolaryngol 2012.
5. Gjuric M, Wigand ME, Wolf SR. Enlarged middle fossa vestibular schwannoma surgery: experience with 735 cases. Otol Neurotol 2001; 22: 223-30. [CrossRef]
6. House WF. Surgical exposure of the internal auditory canal and its contents through the middle, cranial fossa. Laryngoscope 1961; 71: 1363-85. [CrossRef]
7. Fisch U. Transtemporal extralabyrinthine operations on the internal auditory canal, the eighth and the seventh cranial nerves. In: Yasargil G editor. Microsurgery applied to neurosurgery, Stuttgart: Thieme; 1969. p.195-210.
8. Brackmann DE, House JR 3rd, Hitselberger WE. Technical modifications to the middle fossa craniotomy approach in removal of acoustic neuromas. Am J Otol 1994; 15: 614-9.
9. Scheich M, Ginzkey C, Harnisch W, Ehrmann D, Shehata-Dieler W, Hagen R. Use of flexible CO(2) laser fiber in microsurgery for vestibular schwannoma via the middle cranial fossa approach. Eur Arch Otorhinolaryngol 2012; 269: 1417-23. [CrossRef]
10. Becker SS, Jackler RK, Pitts LH. Cerebrospinal fluid leak after acoustic neuroma surgery: a comparison of the translabyrinthine, middle fossa, and retrosigmoid approaches. Otol Neurotol 2003; 24: 107-12. [CrossRef]
11. Oghalai JS, Buxbaum JL, Pitts LH, Jackler RK. The effect of age on acoustic neuroma surgery outcomes. Otol Neurotol 2003; 24: 473-7. [CrossRef]
12. Sameshima T, Fukushima T, McElveen JT Jr, Friedman AH. Critical assessment of operative approaches for hearing preservation in small acoustic neuroma surgery: retrosigmoid vs middle fossa approach. Neurosurgery 2010; 67: 640-4. [CrossRef]
13. Shelton C, Brackmann DE, House WF, Hitselberger WE. Middle fossa acoustic tumor surgery: results in 106 cases. Laryngoscope 1989; 99: 405-8. [CrossRef]
14. Slattery WH 3rd, Francis S, House KC. Perioperative morbidity of acoustic neuroma surgery. Otol Neurotol 2001; 22: 895-902. [CrossRef]
15. Weber PC, Gantz BJ. Results and complications from acoustic neuroma excision via middle cranial fossa approach. Am J Otol 1996; 17: 669-75.
16. Scheich M, Ginzkey C, Ehrmann-Müller D, Shehata-Dieler W, Hagen R. Management of CSF leakage after microsurgery for vestibular schwannoma via the middle cranial fossa approach. Eur Arch Otorhinolaryngol 2016; 273: 2975-81. [CrossRef]
17. Lazard DS, Tosello M, Bozorg-Grayeli A, Vitte E, Bouccara D, Kalamarides M, et al. Early complications and symptoms of cerebellopontine angle tumor surgery: a prospective analysis. Eur Arch Otorhinolaryngol 2011; 268: 1575-82. [CrossRef]
18. Minovi A, Mangold R, Kollert M, Hofmann E, Draf W, Bockmühl U. Functional results, cognitive and effective quality of life disturbances after trans-temporal resection of acoustic neuroma. Laryngorhinootologie 2005; 84: 915-20. [CrossRef]
19. Betka J, Zverina E, Balogova Z, Profant O, Skrivan J, Kraus J, et al. Complications of microsurgery of vestibular schwannoma. Biomed Res Int 2014; 2014: 315952. [CrossRef]
20. Tos M, Thomsen J, Harmsen A. Results of translabyrinthine removal of 300 acoustic neuromas related to tumour size. Acta Otolaryngol Suppl 1988; 452: 38-51. [CrossRef]
21. Samii M, Matthies C. Management of 1000 vestibular schwannomas (acoustic neuromas): surgical management and results with an emphasis on complications and how to avoid them. Neurosurgery 1997; 40: 11-21. [CrossRef]
22. Peppard SB, Dickens JH. Laryngeal injury following short-term intubation. Ann Otol Rhinol Laryngol 1983; 92: 327-30. [CrossRef]
23. Bos MJ, van Rijn MJ, Witteman JC, Hofman A, Koudstaal PJ, Breteler MM. Incidence and prognosis of transient neurological attacks. JAMA 2007; 298: 2877-85. [CrossRef]
24. Stein PD, Beemath A, Olson RE. Trends in the incidence of pulmonary embolism and deep venous thrombosis in hospitalized patients. Am J Cardiol 2005; 95: 1525-6. [CrossRef]
25. Fishman AJ, Hoffman RA, Roland JT Jr, Lebowitz RA, Cohen NL. Cerebrospinal fluid drainage in the management of CSF leak following acoustic neuroma surgery. Laryngoscope 1996; 106: 1002-4. [CrossRef]
26. Nuseir A, Sequino G, De Donato G, Taibah A, Sanna M. Surgical management of vestibular schwannoma in elderly patients. Eur Arch Otorhinolaryngol 2012; 269: 17-23. [CrossRef]
27. Sanna M, Taibah A, Russo A, Falcioni M, Agarwal M. Perioperative complications in acoustic neuroma (vestibular schwannoma) surgery. Otol Neurotol 2004; 25: 379-86. [CrossRef]
28. Geerts WH, Pineo GF, Heit JA, Bergqvist D, Lassen MR, Colwell CW, et al. Prevention of venous thromboembolism: the Seventh ACCP Conference on Antithrombotic and Thrombolytic Therapy. Chest 2004; 126: 338-400. [CrossRef]
29. Cerrato D, Ariano C, Fiacchino F. Deep vein thrombosis and low-dose heparin prophylaxis in neurosurgical patients. J Neurosurg 1978; 49: 378-81. [CrossRef]
30. Hamilton MG, Hull RD, Pineo GF. Venous thromboembolism in neurosurgery and neurology patients: a review. Neurosurgery 1994; 34: 280-96. [CrossRef]
31. Sawaya R. Postoperative venous thromboembolism and brain tumors: Parts I-III. Clinical profil, Hemostatic profile, Biochemical Profile. J Neurooncol 1992; 14: 113-34. [CrossRef]
32. Burckhardt F, Friedrich A, Beier D, Eckmanns T. Clostridium difficile surveillance trends, Saxony, Germany. Emerg Infect Dis 2008; 14: 691-2. [CrossRef]
33. Debast SB, Bauer MP, Kuijper EJ. European Society of Clinical Microbiology and Infectious Diseases: update of the treatment guidance document for Clostridium difficile infection. Clin Microbiol Infect 2014; 20: 1-26.[CrossRef]