Comparison of Facial Nerve Function Outcomes in the Surgical Treatment of Cerebellopontine Angle Lesions with or without Intraoperative Neurophysiological Monitoring

Barış Küçükyürük[1], Emine Taşkıran[2]

[1]Department of Neurosurgery, İstanbul University-Cerrahpaşa, Cerrahpaşa Faculty of Medicine, İstanbul, Turkey
[2]Department of Neurology, İstanbul University-Cerrahpaşa, Cerrahpaşa Faculty of Medicine, İstanbul, Turkey

Cite this article as: *Küçükyürük B, Taşkıran E. Comparison of Facial Nerve Function Outcomes in the Surgical Treatment of Cerebellopontine Angle Lesions with or without Intraoperative Neurophysiological Monitoring. Cerrahpaşa Med J 2021; 45(1): 5-9.*

Abstract

Objective: Intraoperative neurophysiological monitoring (IONM) is commonly used in preserving the function of the facial nerve (FN) during surgery for cerebellopontine angle (CPA) lesions. In this study, we aimed to compare the outcomes of FN function in patients who were treated for CPA lesions with or without IONM.

Methods: This study included 37 patients (22 women, 15 men). The patients were divided in two groups based on whether IONM was used (group 1) or not (group 2). The FN function was graded according to House–Brackmann (HB) Score. HB scores of 1–3 and 4–6 were considered favorable and unfavorable outcomes, respectively. Demographic information, surgical resection rates, type of pathology, and FN function were evaluated retrospectively. Comparisons between groups were conducted using nonparametric tests.

Results: The mean age of the patient group was 45.2±14.82 years and the range was 16–72 years. There were 17 patients in group 1 and 20 patients in group 2. At the 1-year examination, 6 patients (35.3%) in group 1 and 2 patients (10%) in group 2 had unfavorable FN function. A 1-year postoperative comparison of the groups, in terms of the presence of disfiguring FN palsy, showed a statistically significant difference (p=0.03).

Conclusion: The use of IONM during surgery of CPA lesions promoted the preservation of FN function with a secondary benefit of facilitating maximal resection.

Keywords: Cerebellopontine angle, facial nerve, facial nerve outcome, intraoperative neuromonitoring

Serebellopontin Açı Lezyonlarının Cerrahi Tedavisinde İntraoperatif Nöromonitorizasyon Kullanılan ve Kullanılmayan Olguların Fasiyal Sinir Sonuçlarının Karşılaştırılması

Öz

Amaç: İntraoperatif nörofizyolojik monitörizasyon (İONM)serebellopontin köşe (SPK) lezyonları cerrahisinde fasiyal sinir (FS) fonksiyonunu korumak için kullanılır. Bu çalışma, SPK lezyonlarının cerrahi tedavisi esnasında İONM kullanılan ve kullanılmayan hastalarda, FS işlevinin sonuçlarını karşılaştırmayı amaçlamaktadır.

Yöntemler: Bu çalışmaya 37 hasta dahil edildi. Hasta grubu cerrahi tedavi esnasında İONM kullanılıp kullanılmamasına göre iki gruba ayrıldı. Grup 1 İONM kullanılmayan hastaları ve Grup 2 İONM kullanılan hastaları içerdi. FS işlevi, House Brackman (HB) skoruna göre derecelendirildi. HB 1-3 iyi sonuç olarak ve HB 4-6 kötü sonuç olarak kabul edildi. Demografik bilgiler, cerrahi rezeksiyon oranları, patoloji tipi ve FS işlevi geriye dönük olarak değerlendirildi.

Bulgular: Bu çalışmada 22'si kadın 15'i erkek olmak üzere 37 hasta değerlendirildi. Hasta grubunun yaş ortalaması 45,2±14,82, 16 ile 72 arasında idi. Grup 1'de 17 hasta, grup 2'de 20 hasta vardı. Grup 1'de bir yıllık muayenede FN sonucu kötü olan 6 hasta vardı (%35,3) grup 2'de (%10) sadece 2 hastada kötü FN sonucu görüldü. Ameliyat sonrası birinci yılda, yüzde belirgin çarpıklığa sebep olan FS felci açısından gruplar karşılaştırıldığında istatistiksel olarak anlamlı farklılık saptandı (p=0,03).

Sonuç: SPK lezyonlarının cerrahisi sırasında İONM kullanımı, FS işlevinin korunmasını sağlamaktadır; ayrıca daha geniş rezeksiyon oranlarına ulaşılmasını kolaylaştırmaktadır.

Anahtar Kelimeler: Serebellopontin köşe, fasial sinir, fasial sinir işlevi, intraoperative nöromonitorizasyon

The surgical treatment of pathologies situated in the cerebellopontine angle (CPA) aims to provide an optimal treatment for the pathology causing minimal or no neurological deficit to protect the quality of life. Surrounding structures such as the brain stem, branches of the vertebrobasilar arterial system, and several cranial nerves might be endangered in this type of surgery.

Received/Geliş Tarihi: 10.03.2021 **Accepted/Kabul Tarihi:** 14.04.2021
Address for Correspondence/Yazışma Adresi: Barış Küçükyürük, Department of Neurosurgery, İstanbul University-Cerrahpaşa, Cerrahpaşa Faculty of Medicine, İstanbul, Turkey
E-mail/E-posta: baris.kucukyuruk@iuc.edu.tr
DOI: 10.5152/cjm.2021.21011

Neurological deficits of these structures may have deleterious effects on the quality of life of patients. In particular, paralysis of the facial nerve (FN) is reported to have significant psychological and social implications that could lead to depression and poor self-image [1, 2]. To avoid maneuvers that could result in injury to delicate cranial nerves, intraoperative neurophysiological monitoring (IONM) has become an indispensable component of skull base surgery, specifically in the surgery for CPA lesions [3, 4].

In this study, we aimed to report outcomes of FN function in patients who were treated for a lesion located in the CPA. Moreover, we compared results of patients whose surgeries were performed with IONM with those whose surgeries did not include IONM. Finally, we discussed our insight on managing the FN during this type of surgery.

Methods

Patient population

This study included 37 patients who underwent surgery for pathologies located in the CPA. The patient group was divided into two based on whether IONM was used during the surgery or not. IONM has been used routinely in our department, since December 2016, to treat CPA lesions. Therefore, group 1 included 17 patients who underwent surgery before December 2016 and whose treatment did not include IONM while group 2 consisted of 20 patients who underwent surgery after December 2016 with IONM. Group 1 included patients who were not lost to follow-up or could be reached via a telephone call.

FN function was graded using the House–Brackmann (HB) score. HB scores of 1–3 were considered favorable outcomes while scores of 4–6 were considered unfavorable outcomes.

Demographic information, surgical resection rates, type of pathology, and FN outcomes were evaluated retrospectively.

Intraoperative neuromonitoring

Mapping and monitoring techniques were used for IONM of the FN. All recordings, stimulation, and data processing were performed by a clinical neurophysiologist (E.T.) certified for IONM by the International Society of Intraoperative Neurophysiology using a Cadwell Elite IONM system (Cadwell Industries Inc, Kennewick, WA, USA). All patients in group 2 received total intravenous anesthesia consisting of propofol and remifentanil.

The FN was mapped using a monopolar or bipolar handheld stimulating electrode to determine regions of a tumor that were not associated with the FN. The FN was monitored using free run electromyography (EMG), corticobulbar motor evoked potential (CoMEP), and blink reflex (BR). Free run EMG was applied to detect acute-onset injury of the FN. CoMEP of muscles innervated by the FN (m. nasalis, m. orbicularis oculi, m. orbicularis oris, and m. mentalis) was obtained using C3-Cz or C4-Cz montages by activating the corticobulbar tract. BR was performed bilaterally as a tool to monitor brainstem reflexes, evaluate trigeminal afferents, and determine brainstem connections between the trigeminal and facial nuclei and the FN. Our IONM setup and technique have been described in detail elsewhere [5].

Statistical analysis

Data provided in this study were analyzed using the Statistical Package for Social Sciences version 23.0 software (IBM SPSS, Corp., Armonk, NY, USA). Descriptive analysis was used to summarize our study group. The Mann–Whitney U test was used to check the nonparametric elements of our statistical analysis. A P value of <0.05 was considered statistically significant.

Ethical Approval

The study was conducted with the approval of İstanbul University Cerrahpaşa, Cerrahpaşa faculty of med-icine ethics committee (Number: 2020/70721) concordant with the Declaration of Helsinki. Informed consent was obtained in writing from all patients.

Results

Of the 37 patients evaluated in this study, 22 were women and 15 were men. The mean age of the patient group was 45.2±4.82 years ranging between 16 and 72 years. There were 17 patients in group 1 and 20 patients in group 2.

Histopathological diagnoses were vestibular schwannoma (VS) in 30 patients, meningioma in 5, and epidermoid in 2. All the lesions examined in this study reached or compressed the brainstem except in two patients. Of the 30 VSs, 16 were Koos grade 4, 12 were Koos grade 3, and 2 were Koos grade 2. Similarly, 3 meningiomas and 1 epidermoid had reached the brainstem whereas 1 meningioma and 1 epidermoid were large enough to displace the brainstem.

The resection rate was graded as gross total resection (GTR; no remnant tumor on postoperative magnetic resonance imaging), near total resection (NTR; a minimum of 95% resection or remnant in internal acoustic meatus), subtotal resection (STR; 50%–95% resection), or internal decompression (ID; less than 50% resection). There were 17 GTRs, 2 NTRs, 16 STRs, and 2 IDs. These rates differed between the groups; there were 7 and 10 GTRs in groups 1 and 2, respectively; two NTRs in group 2; 10 and 6 STRs in groups 1 and

2, respectively; and 2 IDs in group 2 (Figure 1). There was no statistically significant difference between the groups. An FN deficit was present in 3 patients at the time of admission.

New FN deficit occurred in 18 patients, 9 in each group, immediately after surgical treatment. In group 1, 1, 5, 2, and 1 patient(s) woke up from surgery with HBs score of 3, 4, 5, and 6, respectively, for FN function. These deficits were unchanged at the time of discharge, with the exception of one patient with HB score of 4 for FN palsy whose HB score improved to 3. One-year postoperative FN examination of those in group 1 showed the same results as at discharge, except in two patients who improved 1 point, although both still had disfiguring FN palsy. One year postoperatively, 6 patients in group 1 (35.3%) had unfavorable FN outcomes. In group 2, 4 patients woke up from the surgery with HB 2 FN function, 2 with HB 3, and 3 with HB 5. These deficits were present at the time of discharge, except in two patients with HB 2 FN function whose state improved to a normal condition. One-year postoperative FN examination of patients in group 2 revealed improvements in 2 other patients; therefore, only 2 patients (10%) had an unfavorable FN outcome at this time. Comparison of the groups in terms of the presence of disfiguring FN palsy one year postoperatively showed a statistically significant difference (p=0.03).

Demographic information, surgical resection rates, type of pathology, and FN outcome are evaluated summarized in Table 1.

Table 1. Demographic information, surgical resection rates, type of pathology, and FN outcomes

	Group 1	Group 2	Total
No. of patients	17	20	37
Sex			
Women	10	12	22
Men	7	8	15
Mean age (years)	48.12±12	43.05±16.72	45.22±4.82
Type of pathology			
Vestibular Schwannoma	12	18	30
Meningioma	3	2	5
Epidermoid	2	0	2
Resection Rates			
GTR	7	10	17
NTR	0	2	2
STR	10	6	16
ID	0	2	2
FN outcome at 1st year postoperatively			
HB 1	8	12	20
HB 2	0	3	3
HB 3	3	3	6
HB 4	3	0	3
HB 5	2	2	4
HB 6	1	0	1

FN: facial nerve; GTR: gross total resection; HB: House–Brackmann (score); ID: internal decompression; NTR: near total resection; STR: subtotal resection

Discussion

Surgical treatment of CPA lesions in contemporary series is associated with few mortalities and minimal major morbidity, except for FN palsy [6]. Advances in microsurgical training and skills have significantly improved the FN outcome; however, postoperative FN function is still a major concern for both patients and surgical teams. This is because facial expressions are a sophisticated mechanism essential for relaying emotional information during social interactions [1, 7]. Disrupting this complicated communication tool may disturb both the self-identity of an individual and inferences from observers [1, 8]. Therefore, FN paralysis is a potentially devastating complication of any temporal bone procedure and can result in extensive cosmetic, functional, financial, and psychological consequences [9].

Therefore, the aim of achieving total resection of the pathology with skull base approaches has given way to maintaining patient quality of life. IONM, initially criticized as an unnecessary expenditure, has proved to be an essential tool by facilitating maximal resection while preserving critical structures [9, 10]. Its use in neurosurgical procedures has been shown to decrease neurological complications by as much as 37% [11, 12].

Several studies have compared FN outcomes in a series of surgical cases with and without IONM [6]. Leonetti et al. [13] reported that immediate postoperative FN function was found to be normal in 93% of a group that underwent IONM compared with only 70% in an unmonitored group. Furthermore, they stated that half the patients with new FN palsy in the unmonitored group revealed a severe deficit, whereas no patient in the monitored group had disfiguring palsy [13]. Similarly, Niparko et al. [14] compared results in pa-

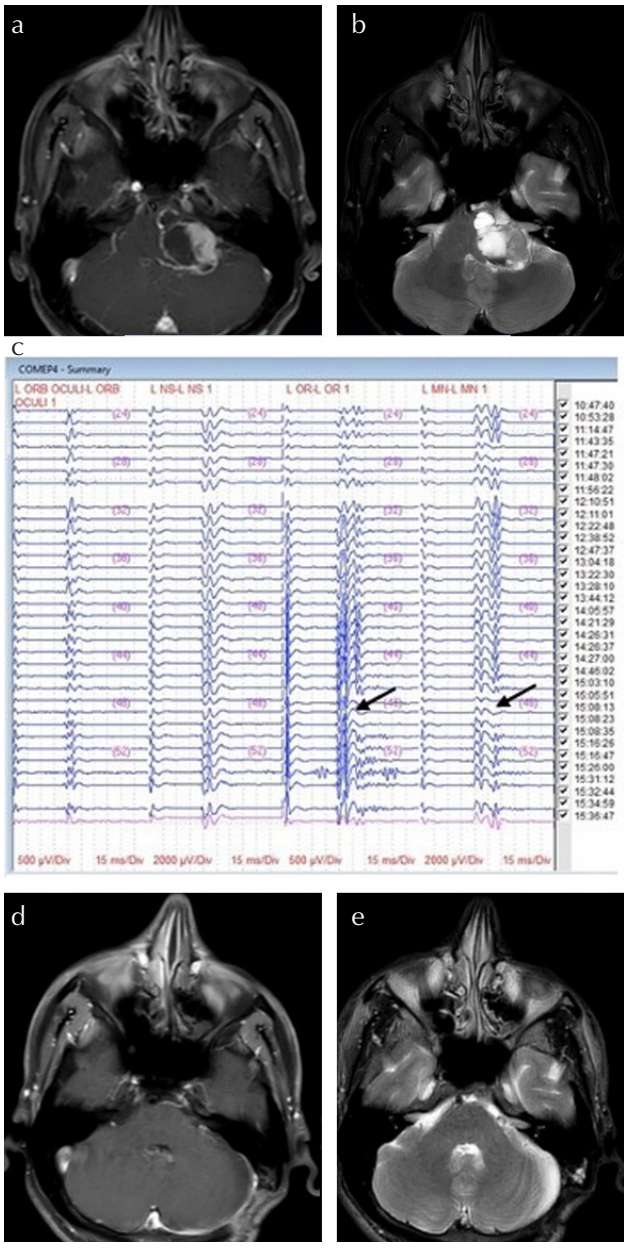

Figure 1. a-e. A 37-years-old male patient admitted with left sided hearing loss and dizziness. Magnetic resonance imaging (MRI) revealed a heterogeneously contrast enhancing lesion at the left cerebellopontine angle (a). T2 weighted images revealed a mass lesion with solid and cystic components (b). Patient was operated in parkbench position and through a retrosigmoid craniotomy using intraoperative neurophysiological monitoring. During the surgery, posterior wall of the internal acoustic canal was drilled to reach to the intracanalicular portion of the tumor, so that gross total resection could be achieved. Figure (c) shows intraoperative corticobulbar motor evoked potential (CoMEP) responses obtained from muscles innervated by the the facial nerve. Black arrows show amplitude decreases less than 50% in orbicularis oris and mentalis muscles during the resection. At the end of resection, all responses were similar to the baseline recordings. Immediate postoperative facial nerve examination revealed no deficit. Postoperative MRI scans (d and e) showed total tumor resection and no damage at the surrounding vital structures. Histopathological examination revealed a vestibular schwannoma

tients who underwent surgery for VS with and without IONM and found that IONM had a statistically significant effect on satisfactory results in tumors larger than 2 cm. Concordant to these, Hammerschlag and Cohen [15] have reported that total FN paralysis occurred in 3.6% and 14.5% of monitored and unmonitored patients, respectively, in a manner that was statistically significant–particularly in tumors larger than 3 cm.

Our findings were similar to those from these previous studies. In this study, in which the focus tumors were larger than 2.5 cm except in two patients, new FN deficit emerged immediately after surgery in 52% of unmonitored patients and 45% of monitored patients. However, one year postoperatively, FN deficit was present in 7 monitored patients, and only 2 of them had a disfiguring facial palsy (HB scores of 4 to 6). However, a disfiguring facial palsy was present in 6 of 9 patients in the unmonitored group. Therefore, we concluded that IONM facilitates obtaining statistically significant better results regarding severe FN outcomes.

We also discerned that surgeon dissection practice during the treatment of CPA lesions differed between the IONM and unmonitored groups [5]. It was found that surgical dissection was stopped whenever surgeons were warned of changes in the IONM modalities. When amplitude decrements were less than 50% or significant morphological changes occurred, a different surgical dissection site was chosen on the tumor. Further decreases caused the surgery to be paused until ameliorating signs were detected via IONM.

In our experience, another advantage of IONM was achieving more resection rates in the monitored group compared to the unmonitored group. Although this finding was not statistically significant, we found that GTR or NTR was achieved in 60% of the monitored patients but in only 41% of unmonitored patients. We believe that this difference in resection rates may be because the surgeon halted the surgical dissection after potentially unsafe maneuvers, which might have led to early termination of the surgery in unmonitored cases.

We conclude that IONM has become an essential tool in skull base surgery, particularly in cases of CPA lesions. It provides better results in terms of disfiguring FN outcomes. In addition, FN palsies are prone to improve over time in a higher number of monitored patients compared to unmonitored patients. Finally, we believe that IONM encourages surgeons to pursue maximal resection by providing actual information on the function of the FN during surgery.

Ethics Committee Approval: Ethics committee approval was received for this study from the ethics committee of İstanbul University Cerrahpaşa, Cerrahpaşa Faculty of Medicine (Number: 2020/70721).

Informed Consent: Written informed consent was obtained from patients who participated in this study.

Peer-review: Externally peer-reviewed.

Author Contributions: Concept – B.K., E.T.; Design – B.K., E.T.; Supervision – B.K., E.T.; Resources – B.K., E.T.; Materials – B.K., E.T.; Data Collection and/or Processing – E.T.; Analysis and/or Interpretation – B.K., E.T.; Literature Search – B.K., E.T.; Writing Manuscript – B.K.; Critical Review – B.K., E.T.

Conflict of Interest: The authors have no conflicts of interest to declare.

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

Etik Komite Onayı: Bu çalışma için etik komite onayı İstanbul Üniversitesi – Cerrahpaşa, Cerrahpaşa Tıp Fakültesi'nden (Referans no: 2020/70721) alınmıştır

Hasta Onamı: Yazılı hasta onamı bu çalışmaya katılan hastalardan alınmıştır.

Hakem Değerlendirmesi: Dış bağımsız.

Yazar Katkıları: Fikir – B.K., E.T.; Tasarım – B.K., E.T.; Denetleme – B.K., E.T.; Kaynaklar – B.K., E.T.; Malzemeler – B.K., E.T.; Veri Toplanması ve/veya İşlemesi – E.T.; Analiz ve/veya Yorum – B.K., E.T.; Literatür Taraması – B.K., E.T.; Yazıyı Yazan – B.K.; Eleştirel İnceleme – B.K., E.T.

Çıkar Çatışması: Yazarlar çıkar çatışması bildirmemişlerdir.

Finansal Destek: Yazarlar bu çalışma için finansal destek almadıklarını beyan etmişlerdir.

References

1. Nellis JC, Ishii M, Byrne PJ, Boahene KDO, Dey JK, Ishii LE. Association Among Facial Paralysis, Depression, and Quality of Life in Facial Plastic Surgery Patients. JAMA Facial Plastic Surg 2017; 19: 190-6. **[Crossref]**
2. Macgregor FC. Facial disfigurement: problems and management of social interaction and implications for mental health. Aesthetic Plast Surg 1990; 14: 249-57. **[Crossref]**
3. Macdonald DB. Intraoperative motor evoked potential monitoring: overview and update. J Clin Monit Comput 2006; 20: 347-77. **[Crossref]**
4. Toleikis JR, American Society of Neurophysiological M. Intraoperative monitoring using somatosensory evoked potentials. A position statement by the American Society of Neurophysiological Monitoring. J Clin Monit Comput 2005; 19: 241-58. **[Crossref]**
5. Taşkıran E, Küçükyürük B. Intraoperative Neurophysiology Practice in the Surgical Treatment of Posterior Fossa Lesions: Cerrahpaşa Experience. İstanbul Med J 2020; 21: 344-9. **[Crossref]**
6. Lalwani AK, Butt FY, Jackler RK, Pitts LH, Yingling CD. Facial nerve outcome after acoustic neuroma surgery: a study from the era of cranial nerve monitoring. Otolaryngol Head Neck Surg. 1994; 111: 561-70. **[Crossref]**
7. Frith C. Role of facial expressions in social interactions. Philos Trans R Soc Lond B Biol Sci 2009; 364: 3453-8. **[Crossref]**
8. Shaw WC. Folklore surrounding facial deformity and the origins of facial prejudice. Br J Plast Surg 1981; 34: 237-46. **[Crossref]**
9. Gidley PW, Maw J, Gantz B, Kaylie D, Lambert P, Malekzadeh S, et al. Contemporary Opinions on Intraoperative Facial Nerve Monitoring. OTO Open 2018; 2: 2473974X18791803. **[Crossref]**
10. Wilson L, Lin E, Lalwani A. Cost-effectiveness of intraoperative facial nerve monitoring in middle ear or mastoid surgery. Laryngoscope 2003; 113: 1736-45. **[Crossref]**
11. Cochrane DD, Gustavsson B, Poskitt KP, Steinbok P, Kestle JR. The surgical and natural morbidity of aggressive resection for posterior fossa tumors in childhood. Pediatr Neurosurg 1994; 20: 19-29. **[Crossref]**
12. Dubey A, Sung WS, Shaya M, Patwardhan R, Willis B, Smith D, et al. Complications of posterior cranial fossa surgery--an institutional experience of 500 patients. Surg Neurol 2009; 72: 369-75. **[Crossref]**
13. Leonetti JP, Brackmann DE, Prass RL. Improved preservation of facial nerve function in the infratemporal approach to the skull base. Otolaryngol Head Neck Surg 1989; 101: 74-8. **[Crossref]**
14. Niparko JK, Kileny PR, Kemink JL, Lee HM, Graham MD. Neurophysiologic intraoperative monitoring: II. Facial nerve function. Am J Otol 1989; 10: 55-61.
15. Hammerschlag PE, Cohen NL. Intraoperative monitoring of facial nerve function in cerebellopontine angle surgery. Otolaryngol Head Neck Surg 1990; 103: 681-4. **[Crossref]**