ORIGINAL RESEARCH

Effects of Surgical Timing of Facial Nerve Decompression for Patients With Severe Bell's Palsy

Pu Wang, MD; Yubin Xue, MD; Liming Gao, MD; Qiang Liu, MD; Wenyang Zhang, MD; Yin Xia, MD

ABSTRACT

Context • Bell's palsy is a form of idiopathic, facial nerve palsy. Initial treatment includes the use of oral corticosteroids and/or antiviral agents, but facial paralysis may persist. Some surgeons suggest that surgical decompression of the facial nerve can be a beneficial, but the optimal surgical approach, extent of nerve decompression, and timing of surgery remain unclear.

Objective • This study intended to evaluate the efficacy of delayed, facial nerve decompression for severe Bell's palsy (BP) and to explore the relationship of opportunity timing for operations, with postoperative recovery for facial nerve function.

Design • The research team performed a retrospective study.

Setting • The study took place at Beijing Tiantan Hospital of Capital Medical University in Beijing, China.

Participants • Participants were 45 patients who had been diagnosed with BP between 2015 and 2021 and who had undergone facial nerve decompression using the transmastoid approach, between 30 and 180 days after the onset of BP. According to the operation's timing, the research team divided the participants into three groups, consisting of participants who underwent surgery: (1) at 30-60-days after BP onset—19 participants, (2) at 61-90 days after BP onset—18 participants, and (3) at more than 90 days after BP onset—8 participants.

Outcome Measures • The research team: (1) analyzed participants' demographic and preoperative and postoperative clinical characteristics, (2) compared the surgical outcomes with participants' House-Brackmann (HB) scales, and (3) analyzed the factors affecting the recovery of facial nerve function using logistic regression.

Results • Decompression surgery was effective for 29 participants (64.4%), with similar rates for participants who underwent surgery after 30-60 days (73.7%) and 61-90 days (77.8%), but the surgery' success was significantly higher for those groups than for participants who underwent surgery after >90 days (12.5%), with $P = .008$ and $P = .003$, respectively. Multivariate logistic regression analysis showed that disease duration was the only factor significantly associated with the effectiveness of surgery (odds ratio = 120.337; 95% confidence interval 2.997-4832.267, $P = .011$).

Conclusions • For patients with severe Bell's palsy with ineffective conservative treatment, surgery performed 30 to 90 days after the onset of paralysis can have therapeutic benefits, whereas surgery performed after 3 months is relatively ineffective. (*Altern Ther Health Med.* 2023;29(2):70-75)

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Bell's palsy is a form of idiopathic, facial nerve palsy that usually manifests as sudden weakness of the muscles responsible for facial expression on one side of the face. Additional symptoms include hyperacusis, changes in taste, abnormal facial sensations or pain, and epiphora.[1,2]

The incidence of Bell's palsy is 20 to 40 per 100 000 persons per year and is highest in those aged ≥70 years. The average age at onset is 40 years old, with men and women being equally affected.[3,4] Although the exact cause of Bell's palsy isn't known, it may be related to autoimmune inflammatory disorders, viral infections, ischemia, heredity, and/or cold stimulation.[5]

Facial paralysis can have a significant negative impact on an individual's psychosocial well-being and interactions with others in society. It's crucial to identify patients with this condition and to optimize recovery of facial function. The American Academy of Neurology's evidence-based guidelines have suggested the use of oral corticosteroids and/or antiviral agents to treat patients with Bell's palsy to improve facial-function recovery. [6,18] Clinically, few patients are willing to undergo surgery within 2 weeks of onset, and most aren't willing to undergo surgery until conservative treatment fails in one month.

Reich found that treatment with prednisolone and a placebo, prednisolone and acyclovir, a placebo and a placebo, or acyclovir and a placebo could effectively enhance recovery within 3 months after disease onset, but the treatments were less effective at later times.[4]

Yamagishi et al and Hato et al found that although appropriate initial treatment can result in a complete cure in approximately 75% to 94% of patients, facial paralysis may persist in others.[7,8] In addition, Yamagishi et al found that patients with severe Bell's palsy—a House-Brackmann (HB) score of V-VI at one month—have a 60%-90% predicted risk of nonrecovery at 12 months.[7]

Linder et al found that some patients with severe paralysis had no progress in facial function and still remained at HB grade V/VI even at two months after onset, even though they had received steroid treatments at the acute paretic phase.[19] Mantsopoulos et al and Takemoto et al found that patients who receive ineffective treatment can suffer sequelae with facial asymmetry, contracture, and synkinesis of the mimic muscles.[9,10]

Facial Nerve Decompression

Some surgeons suggest that surgical decompression of the facial nerve can be a beneficial management option because it can release the nerve's entrapment in the facial canal. However, the American Academy of Otolaryngology-Head and Neck Surgery's clinical guidelines committee on Bell's palsy couldn't conclude that facial nerve decompression is effective.[15]

McAllister et al first reported using facial nerve decompression for severe Bell's palsy in 1932; that operation consisted of slitting the sheath in the descending segment of the nerve.[20] Since then, areas of decompression have ranged from the meatal fundus to the stylomastoid foramen.

Fisch et al's study found that the most likely site for neural compression and a conduction block in Bell's palsy was at the entrance to the meatal foramen and the labyrinthine segment.[12] The participants in that study were patients who were considered candidates for surgery if they had >90% degeneration based on electroneuronography; had no voluntary, electromyography, motor-unit potentials; and had sought treatment within 14 days of symptom onset.[12] Those researchers, Vakharia and Vakharia, and Gantz et al all performed middle, cranial fossa decompression of the tympanic segments, geniculate ganglion, labyrinthine segment, and meatal foramen. [3,11,12]

The main surgical approaches are the transmastoid and the middle cranial fossa approaches. The middle cranial fossa approaches exposes and decompresses the facial nerve's labyrinthine segment and geniculate ganglion, whereas the transmastoid approach decompresses the facial nerve's vertical, pyramidal, and tympanic segments and its geniculate ganglion.[11,12]

The transmastoid approach has shown good clinical results and greater nerve recovery than the middle cranial fossa approach,[21-25] with an effective facial nerve decompression of 61.1%-75%.[24,25] A systematic review and meta-analysis reported in 2019 that the recovery of facial nerve function was independent of the surgical approach used, with no significant difference in treatment outcomes whether surgeons used the transmastoid or the middle cranial fossa approach for facial nerve decompression.[26]

Delayed Decompression

Bodenez et al indicate that it's still debatable as to whether delayed decompression can provide therapeutic benefits to patients with severe paralysis who have been treated with steroids.[13] Gantz et al and May et al indicate that it's uncertain whether decompression beyond two or three weeks after the onset of Bell's palsy can improve functional outcomes or whether those patients can achieve complete recovery through decompression beyond 10 days.[11,27]

Li compared the effectiveness of delayed surgery for patients with severe Bell's palsy using follow-up observation of two groups—one between two and three months after onset and the other at three months after onset.[14] Those researchers found that those patients didn't benefit from delayed decompression surgery after two months from onset.

However, Hagino found swelling of the mastoid segment and entrapment of the facial nerve in the patients during surgery at 28-65 days after disease onset.[28] These findings suggest that inflammatory processes may persist for up to or even beyond 90 days following the onset of Bell's palsy, followed by the process of fibrotic remodeling, which can maintain intrinsic compression on the nerve. Berania et al found that surgical decompression could relieve that inflammatory process.[25] Schwaber et al confirmed the existence of inflammatory edema at three months after onset of the disease using gadolinium-enhanced MRI.[29]

Current Study

The optimal surgical approach, extent of nerve decompression, and timing of surgery remain unclear. The current study intended to evaluate the efficacy of delayed, facial nerve decompression for severe Bell's palsy (BP) and to explore the relationship of opportunity timing for operations, with postoperative recovery for facial nerve function.

METHODS

Participants

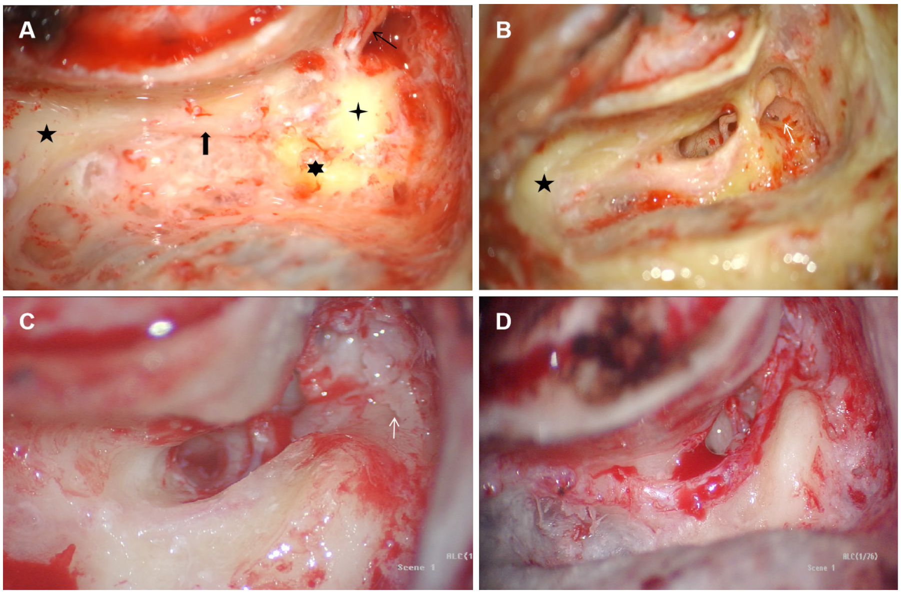
The research team performed a retrospective study. The study took place at Beijing Tiantan Hospital of Capital Medical University in Beijing, China. Potential participants were patients who had been diagnosed with BP between 2015 and 2021 and who had undergone facial nerve decompression using the transmastoid approach, between 30 and 180 days after the onset of BP.

Potential participants were included in the study if they: (1) continued to have severe facial paralysis after 2-4 weeks of standard conservative treatment—oral corticosteroids, antiviral agents, and/or acupuncture; (2) had BP defined as House-Brackmann (HB) grade V or VI prior to surgical intervention; (3) showed degeneration of >85 % on electroneuronography (ENoG) that was performed between 7 and 14 days from the onset of their facial weakness; (4) weren't satisfied with their recovery of facial nerve function and strongly desired surgery for facial nerve decompression using the transmastoid approach after a month of conservative treatment.

Potential participants were excluded from the study if they had other autoimmune diseases or hematologic disorders.

All participants signed informed consent forms. The Review Committee of Beijing Tiantan Hospital (NO: QX2016-016-011) approved the study's protocols.

Figure 1. Surgical Highlights. Figure 1A shows that the facial nerve's mastoid segment is located through the digastric ridge and short process of incus, the lateral semicircular canal, and the posterior semicircular canal. Figure 1B shows the facial recess opened to expose the incudostapedial joint; the exposure of the facial nerve's tympanic segment and geniculate ganglion requires the removal of the incus, the posterior buttress, and the cog. Figure 1C shows that the exposure of the geniculate ganglion after removal of the incus and the posterior buttress requires the removal of the cog. Figure 1D shows the facial nerve's exposure and decompression from the geniculate ganglion to the stylomastoid foramen.



Procedures

Data collection. We recorded each participant's demographic and clinical data, including gender, age, affected side, HB scoring, disease duration, presence of ear pain and/or tinnitus at the onset of BP, hypertension, and diabetes.

Groups. According to the operation's timing, the research team initially divided the participants into three groups, consisting of participants who underwent surgery: (1) at 30-60 days after BP onset, (2) at 61-90 days after BP onset, and (3) at more than 90 days after BP onset.

Facial nerve decompression using the transmastoid approach. A single experienced surgeon performed all the transmastoid decompression operations. A transmastoid approach uses decompression of the intratemporal facial nerve from the geniculate ganglion to the stylomastoid foramen. Following a mastoidectomy of the intact canal wall through a retroauricular incision, the surgeon: (1) exposes the facial nerve's mastoid segment; (2) locates the facial nerve at the stylomastoid foramen through the digastric ridge; (3) locates the facial nerve's pyramidal segment through the short process of the incus, the lateral semicircular canal, and the posterior semicircular canal; (4) exposes the facial nerve's vertical segment between the stylomastoid foramen and the facial nerve's pyramidal segment (Figure 1A); (5) to obtain wide access to the facial nerve's geniculate ganglion and horizontal segment, removes the attic lateral wall, the incus, and the head of the malleus (Figures 1B and 1C); (6) removes the cog, exposing the facial nerve's geniculate ganglion and horizontal segment (Figure 1D); (7) after exposing at least 50% of the facial nerve's surface, cuts the sheath from the geniculate ganglion to the stylomastoid foramen; and (8) uses a titanic ossicular replacement prosthesis to reconstruct the ossicular.

Figure 1A shows that the facial nerve's mastoid segment is located through the digastric ridge and short process of the incus, the lateral semicircular canal, and the posterior semicircular canal. Figure 1B shows the facial recess opened to expose the incudostapedial joint; the exposure of the facial nerve's tympanic segment and geniculate ganglion requires the removal of the incus, the posterior buttress, and the cog. Figure 1C shows that the exposure of the geniculate ganglion after removal of the incus and the posterior buttress requires the removal of the cog. Figure 1D shows the facial nerve's exposure and decompression from the geniculate ganglion to the stylomastoid foramen.

Outcome measures. The research team: (1) analyzed participants' demographic and preoperative and postoperative clinical characteristics, (2) compared the surgical outcomes with participants' HB sclaes, and (3) analyzed the factors affecting the recovery of facial nerve function using univariate and multivariate logistic regression.

For evaluation of surgical outcomes, the research team divided the participants into two groups: (1) those who recovered facial nerve function to HB grade I-II, and (2) those whose HB level postintervention was HB III or above.

Table 1 Demographic and Clinical Characteristics of Participants With Severe Bell's Palsy

	Baseline Total n = 45 Mean ± SD n (%)	Postintervention Recovery After Surgery HB I-II n = 29 Mean ± SD n (%)	HB III or Above n = 16 Mean ± SD n (%)	*P* value
Age, y	46.2 ± 14.99	43.69 ± 15.79	50.75 ± 12.64	.060
Gender				.878
Male	26 (57.78)	17 (58.62)	9 (56.25)	
Female	19 (42.22)	12 (41.38)	7 (43.75)	
Affected Side				.486
Left	25 (55.56)	15 (51.72)	10 (62.50)	
Right	20 (44.44)	14 (48.28)	6 (37.50)	
Ear Pain				1.000
Yes	7 (15.56)	5 (17.24)	2 (12.50)	
No	38 (84.44)	24 (82.76)	14 (87.50)	
Tinnitus				.292
Yes	10 (22.22)	8 (27.59)	2 (12.50)	
No	35 (77.78)	21 (72.41)	14 (87.50)	
Hypertension				1.000
Yes	8 (17.78)	5 (17.24)	3 (18.75)	
No	37 (82.22)	24 (82.76)	13 (81.25)	
Diabetes				.686
Yes	7 (15.56)	4 (13.79)	3 (18.75)	
No	38 (84.44)	25 (86.21)	13 (81.25)	
ENoG (Oculi)	0.91 ± 0.07	0.91 ± 0.07	0.90 ± 0.07	.500
ENoG (Oris)	0.90 ± 0.06	0.92 ± 0.07	0.90 ± 0.06	.140
Disease Duration				
≤3 months	37 (82.22)	28 (96.55)	9 (56.25)	.002[a]
>3 months	8 (17.78)	1 (3.45)	7 (43.75)	<.050[a]

[a]*P* < .05, indicating that the HB grade I-II group had significantly greater improvement in facial nerve function than the HB III or above group for both subgroups, those who underwent surgery after symptom onset at ≤3 months or those who underwent it at >3 months

The research team divided those two groups into two subgroups, participants with a disease duration after BP onset of ≤ 3 month and those with duration of >3 months.

Preoperative and postoperatively, the research team also measured: (1) participants' hearing, and (2) performed electroneuronography (ENoG) Oculi and Oris tests.
The research team also determined if any long-term surgical complications had occurred.

Outcome Measures

Hearing. The research team assessed each participant's hearing at four frequencies—500, 1000, 2000 and 4000 Hz. These are frequencies that medical practitioners often measure clinically at 3 months after surgery and then calculate pure tone averages (PTAs).[16] The team assessed the final hearing result at the last clinic visit after surgery.

ENoG. Oculi and Oris to evaluate facial nerve function to establish how badly nerves have been disrupted and determine potentially necessary surgeries in the future.

House-Brackmann (HB) score. The research team assessed each participant's grade of facial palsy using the HB test, for at least 12 months until the participant achieved full recovery. The team defined the HB grades I and II as good outcomes or complete recovery.[17]

Statistical Analyses

The research team performed all statistical analyses using IBM SPSS Statistics 26.0 software (IBM, LA, USA). The team: (1) tested the measurement data for normality, and (2) expressed data conforming to normal distribution as means ± standard deviations (SDs) and data not conforming to normal distribution as medians and interquartiles. For comparison between groups, if the three groups of data met the principle of homogeneity of normal variance, the team used analysis of variance (ANOVA); otherwise, the team used nonparametric statistical tests. The team compared the data using Student's *t* tests, Fisher's exact tests, or Chi-square tests, as appropriate. The team also assessed the relationships of demographic and clinical factors with the recovery of facial nerve function using logistic regression analyses. A $P < .05$ was considered to be statistically significant.

RESULTS

Participants

The study included and analyzed the data of 45 patients with Bell's palsy (Table 1), including 26 men (57.78%) and 19 women (42.22%). Their mean age at diagnosis was 46.2 ± 14.99 years. All patients had unilateral facial paralysis, 25 on the left side (55.56%) and 20 on the right side (44.44%). Seven patients reported ear pain (15.56%), and 10 reported tinnitus at the onset of symptoms (22.22%). Before surgery, eight patients had hypertension (17.78%), and seven had diabetes mellitus (15.56%).

Postoperative Facial Nerve Recovery

Of the 45 participants, 29 recovered facial nerve function to HB grade I-II (64.4%). No significant differences existed in gender; age; affected side; or preoperative rates of ear pain, tinnitus, hypertension, and diabetes between the 29 participants who recovered and the 16 who didn't.

The mean ENoG (Oculi) results in the participants who recovered and those who didn't were 0.91 ± 0.07 and 0.90 ± 0.07, respectively, with no significant difference between the groups. Additionally, the mean ENoG (Oris) results in the two groups were 0.92 ± 0.02 and 0.90 ± 0.02, respectively, again with no significant difference.

The HB grade I-II group had significantly greater improvement in facial nerve function than the HB III or above group, for both subgroups, those who underwent surgery after symptom onset at ≤3 months ($P = .002$) or those who underwent it at >3 months ($P < .05$).

Other Postoperative Results

Before surgery, 40 participants had normal hearing, with an average hearing of 18 dB, and 5 had mild, sensory, neural hearing loss, with an average hearing of 36 dB (data not shown). After surgery, 21 participants had normal hearing, with an average hearing of 23 dB; 19 had mild hearing loss, with an average hearing of 38 dB; and 5 had severe hearing loss, with an average hearing of 56 dB (data not shown).

Twenty patients had tinnitus after surgery (data not shown). None of those patients had postoperative complications, such as dizziness, tympanic membrane perforation, middle ear infection, or cerebrospinal fluid leakage (data not shown).

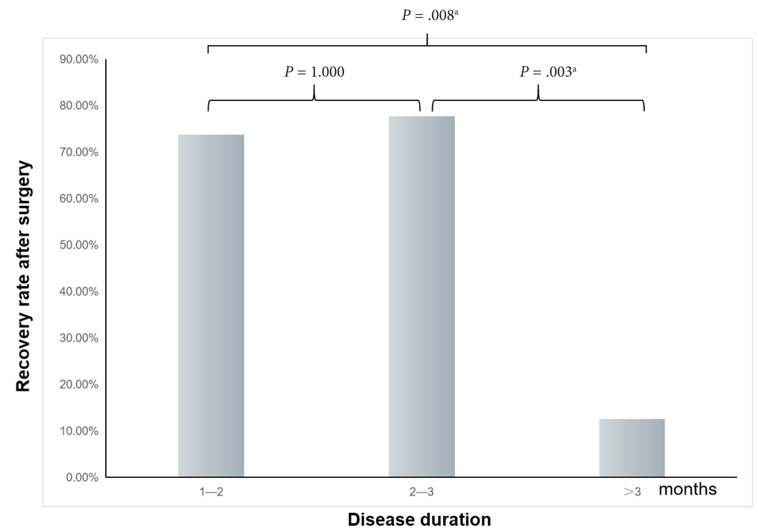
Disease Duration

The disease duration at baseline prior to surgery ranged from 30 to 180 days. Of the 45 participants, 19 (42.2%), 18 (40.0%), and 8 (17.8%) underwent surgery at 30 to 60 days, 61 to 90 days, or >90 days, respectively, after onset of symptoms.

Univariate Analysis of Risk Factors

Figure 2 shows the univariate logistic regression analysis for the association of disease duration with facial nerve recovery rate after surgery. Of the 29 participants who recovered facial nerve function, 14 with a disease duration of 30 to 60 days (73.7%), 14 with a disease duration of 61 to 90 days (77.8%), and one with a disease duration of >90 days (12.5%), showed postoperative clinical improvement to HB II or better at the last follow-up visit (data not shown). Compared with the participant with facial nerve recovery who underwent surgery after >90 days, participants who underwent surgery after 30 to 60 days ($P = .008$) and after 61 to 90 days ($P = .003$) had significantly greater improvement in facial nerve function, although the rates didn't differ significantly between those two groups ($P = 1.000$).

Figure 2. The Association of Disease Duration With Facial Nerve Recovery Rate After Surgery, Using Univariate Logistic Regression Analysis



$P < .05$, indicating that participants with facial nerve recovery who underwent surgery after 30 to 60 days (1-2 months) and after 61 to 90 days (2-3 months) had significantly greater improvement in facial nerve function than the one participant who had facial nerve recovery and underwent surgery after >90 days (<3 months)

Multivariate Analysis of Risk Factors

Table 2 shows the multivariate logistic regression analysis of the factors affecting the recovery of facial nerve function after surgery. Of those factors, including gender, age, side, disease duration, ear pain, tinnitus, hypertension, diabetes, and ENoG (Oculi) and ENoG (Oris), only disease duration prior to surgery had a statistically significant effect on the recovery postoperatively from facial paralysis (odds ratio = 120.337, 95% confidence interval 2.997-4832.267, $P = .011$).

Table 2. Multivariate Logistic Regression Analysis of the Factors Affecting the Recovery of Facial Nerve Function After Surgery

							95% CI for EXP(B)	
	B	SE	Wald	df	*P* value	Exp(B)	Lower	Upper
Gender	-1.014	1.04	0.951	1	.330	0.363	0.047	2.785
Age	-0.044	0.032	1.9	1	.168	0.957	0.899	1.019
Side	-0.678	0.935	0.526	1	.468	0.508	0.081	3.172
Disease duration	4.79	1.884	6.464	1	.011[a]	120.337	2.997	4832.267
Ear pain	0.343	1.447	0.056	1	.813	1.409	0.083	24.033
Tinnitus	-1.047	1.155	0.821	1	.365	0.351	0.036	3.377
Hypertension	-0.083	1.168	0.005	1	.943	0.92	0.093	9.077
Diabetes	1.061	1.258	0.712	1	.399	2.891	0.246	33.995
ENoG (Oculi)	1.096	1.235	0.788	1	.375	2.993	0.266	33.698
ENoG (Oris)	-2.053	1.47	1.951	1	.162	0.128	0.007	2.289
Constant	0.138	2.666	0.003	1	.959	1.148		

[a]$P = .011$, indicating that the facial nerve recovery rate was significantly better for participants who underwent surgery at ≤3 months after symptom onset than for those who underwent it at >3 months

DISCUSSION

The study compared the outcomes of delayed surgery using the physician-based HB sclae. Participants who underwent surgery within 90 days had significantly greater improvement in facial nerve function with patients who underwent surgery after >90 days. The disease duration prior to surgery might be the only risk factor affecting postoperative recovery from facial paralysis.

Because a systematic review and meta-analysis reported that the recovery of facial nerve function was independent of the surgical approach used,[26] we recommend transmastoid decompression of the facial nerve for patients with severe Bell's palsy.

The present study found that the rate of effective facial nerve decompression was 64.4% (29/45), which was similar to findings in other studies (61.1%-75%).[24,25]

Factors influencing the efficacy of facial nerve decompression in patients with Bell's palsy, could include gender, age, side, disease duration, ear pain, tinnitus, hypertension, diabetes, and ENoG (Oculi and Oris). The present study showed that disease duration was the only factor that influenced postoperative recovery from facial paralysis as assessed by logistic regression analysis, which was consistent one study previous results.[30]

The current study had some limitations. A larger sample size is required for validation. In addition, the outcome measures for the recovery of delayed facial nerve decompression in patients with severe BP was few and simple; more relevant scales should be considered to evaluate the results.

CONCLUSIONS

For patients with severe Bell's palsy with ineffective conservative treatment, surgery performed 30 to 90 days after the onset of paralysis can have therapeutic benefits, whereas surgery performed after 3 months was relatively ineffective.

AUTHORS' DISCLOSURE STATEMENT

The authors have no conflicts of interest to declare.

REFERENCES

1. Baugh RF, Basura GJ, Ishii LE, et al. Clinical practice guideline: bell's palsy. *Otolaryngol Head Neck Surg*. 2013;149(3)(suppl):S1-S27. doi:10.1177/0194599813505967
2. Kline LB, Kates MM, Tavakoli M. Bell Palsy. *JAMA*. 2021;326(19):1983. doi:10.1001/jama.2021.18504
3. Vakharia K, Vakharia K. Bell's Palsy. *Facial Plast Surg Clin North Am*. 2016;24(1):1-10. doi:10.1016/j.fsc.2015.08.001
4. Reich SG. Bell's Palsy. *Continuum (Minneapoli Minn)*. 2017; 23(2, Selected Topics in Outpatient Neurology):447-466.
5. Zhang W, Xu L, Luo T, Wu F, Zhao B, Li X. The etiology of Bell's palsy: a review. *J Neurol*. 2020;267(7):1896-1905. doi:10.1007/s00415-019-09282-4
6. Marsk E, Bylund N, Jonsson L, et al. Prediction of nonrecovery in Bell's palsy using Sunnybrook grading. *Laryngoscope*. 2012;122(4):901-906. doi:10.1002/lary.23210
7. Gronseth GS, Paduga R; American Academy of Neurology. Evidence-based guideline update: steroids and antivirals for Bell palsy: report of the Guideline Development Subcommittee of the American Academy of Neurology. *Neurology*. 2012;79(22):2209-2213. doi:10.1212/WNL.0b013e318275978c
8. Yamagishi T, Ohshima S, Yagi C, et al. Nerve integrity monitor responses to direct facial nerve stimulation during facial nerve decompression surgery can predict postoperative outcomes. *Otol Neurotol*. 2020;41(5):704-708. doi:10.1097/MAO.0000000000002594
9. Hato N, Yamada H, Kohno H, et al. Valacyclovir and prednisolone treatment for Bell's palsy: a multicenter, randomized, placebo-controlled study. *Otol Neurotol*. 2007;28(3):408-413. doi:10.1097/01.mao.0000265190.29969.12
10. Linder TE, Abdelkafy W, Cavero-Vanek S. The management of peripheral facial nerve palsy: "paresis" versus "paralysis" and sources of ambiguity in study designs. *Otol Neurotol*. 2010;31(2):319-327. doi:10.1097/MAO.0b013e3181cabd90
11. Mantsopoulos K, Psillas G, Psychogios G, Brase C, Iro H, Constantinidis J. Predicting the long-term outcome after idiopathic facial nerve paralysis. *Otol Neurotol*. 2011;32(5):848-851. doi:10.1097/MAO.0b013e31821da2c6
12. Takemoto N, Horii A, Sakata Y, Inohara H. Prognostic factors of peripheral facial palsy: multivariate analysis followed by receiver operating characteristic and Kaplan-Meier analyses. *Otol Neurotol*. 2011;32(6):1031-1036. doi:10.1097/MAO.0b013e31822558de
13. Grogan PM, Gronseth GS. Practice parameter: Steroids, acyclovir, and surgery for Bell's palsy (an evidence-based review): report of the Quality Standards Subcommittee of the American Academy of Neurology. *Neurology*. 2001;56(7):830-836. doi:10.1212/WNL.56.7.830
14. McAllister K, Walker D, Donnan PT, Swan I. Surgical interventions for the early management of Bell's palsy. *Cochrane Database Syst Rev*. 2013;(10):CD007468. doi:10.1002/14651858.CD007468.pub3
15. Fisch U. Surgery for Bell's palsy. *Arch Otolaryngol*. 1981;107(1):1-11. doi:10.1001/archotol.1981.00790370003001
16. Gantz BJ, Rubinstein JT, Gidley P, Woodworth GG. Surgical management of Bell's palsy. *Laryngoscope*. 1999;109(8):1177-1188. doi:10.1097/00005537-199908000-00001
17. Yanagihara N, Hato N, Murakami S, Honda N. Transmastoid decompression as a treatment of Bell palsy. *Otolaryngol Head Neck Surg*. 2001;124(3):282-286. doi:10.1067/mhn.2001.112309
18. Wu SH, Chen X, Wang J, Liu H, Qian XZ, Pan XL. Subtotal facial nerve decompression in preventing further recurrence and promoting facial nerve recovery of severe idiopathic recurrent facial palsy. *Eur Arch Otorhinolaryngol*. 2015;272(11):3295-3298. doi:10.1007/s00405-014-2991-9
19. Yasumura S, Watanabe Y, Aso S, Asai M, Ito M, Mizukoshi K. Result of decompression surgery in late-stage severe facial paralysis. *Acta Otolaryngol Suppl*. 1993;504(sup504):134-136. doi:10.3109/00016489309128139
20. Kim SH, Jung J, Lee JH, Byun JY, Park MS, Yeo SG. Delayed facial nerve decompression for Bell's palsy. *Eur Arch Otorhinolaryngol*. 2016;273(7):1755-1760. doi:10.1007/s00405-015-3762-y
21. Berania I, Awad M, Saliba I, Dufour JJ, Nader ME. Delayed facial nerve decompression for severe refractory cases of Bell's palsy: a 25-year experience. *J Otolaryngol Head Neck Surg*. 2018;47(1):1. doi:10.1186/s40463-017-0250-y
22. Lee SY, Seong J, Kim YH. Clinical implication of facial nerve decompression in complete Bell's palsy: A systematic review and meta-analysis. *Clin Exp Otorhinolaryngol*. 2019;12(4):348-359. doi:10.21053/ceo.2019.00535
23. Bodénez C, Bernat I, Willer JC, Barré P, Lamas G, Tankéré F. Facial nerve decompression for idiopathic Bell's palsy: report of 13 cases and literature review. *J Laryngol Otol*. 2010;124(3):272-278. doi:10.1017/S0022215109991265
24. May M, Blumenthal F, Taylor FH. Bell's palsy: surgery based upon prognostic indicators and results. *Laryngoscope*. 1981;91(12):2092-2103.
25. Li Y, Sheng Y, Feng GD, Wu HY, Gao ZQ. Delayed surgical management is not effective for severe Bell's palsy after two months of onset. *Int J Neurosci*. 2016;126(11):989-995. doi:10.3109/00207454.2015.1092144
26. Hagino K, Tsunoda A, Tsunoda R, Kishimoto S. Measurement of the facial nerve caliber in facial palsy: implications for facial nerve decompression. *Otol Neurotol*. 2011;32(4):686-689. doi:10.1097/MAO.0b013e318210b8e2
27. Schwaber MK, Larson TC III, Zealear DL, Creasy J. Gadolinium-enhanced magnetic resonance imaging in Bell's palsy. *Laryngoscope*. 1990;100(12):1264-1269. doi:10.1288/00005537-199012000-00003
28. Joseph AR, Shaw JL, Clouser MC, MacGregor AJ, Dougherty AL, Galarneau MR. Clinical audiometric patterns of hearing loss following blast-related injury in U.S. military personnel. *Int J Audiol*. 2020;59(10):772-779. doi:10.1080/14992027.2020.1743884
29. House JW, Brackmann DE. Facial nerve grading system. *Otolaryngol Head Neck Surg*. 1985;93(2):146-147. doi:10.1177/019459988509300202
30. Wang JJ, Feng YM, Wu YQ, et al. Factors influencing the efficacy of facial nerve decompression. 2016; 36:1329-1332.