REVIEW ARTICLE

Is There a Cranial Nerve Other Than the 7th Co-Involved in Bell's Palsy? Answer to the Systematic Review

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ABSTRAK

Bell's palsy dicirikan oleh kerosakan neuron motor bahagian bawah sebelah pada saraf muka. Walaupun Bell's palsy melibatkan palsi saraf muka periferi, saraf kranial lain perlu dikaji kerana ia saling berkaitan secara anatomi dan bukannya terpencil.

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Matlamat kajian ini adalah untuk mencari bukti saraf kranial lain terlibat dalam Bell's palsy. Carian menyeluruh telah dijalankan menggunakan lima pangkalan data elektronik, iaitu CINAHL, Academic Search Complete, MEDLINE, SPORTDiscus, dan Scopus, yang semuanya dikemas kini sehingga Mei 2021. Penyelidikan Bell's Palsy memfokuskan kepada asal-usul dan punca keadaan, tanpa mengira reka bentuk kajian, layak untuk dimasukkan. Penyelidikan haiwan, kajian bukan Bahasa Inggeris, kesusasteraan kabur, kajian tanpa teks penuh tersedia, dan yang diterbitkan dalam jurnal bukan semakan, dikecualikan. Walaupun 3883 kertas ditemui semasa pencarian awal, hanya 13 telah dimasukkan dalam kajian akhir. Manual Institut Joanna Briggs untuk sintesis bukti dan piawaian bukti Sackett digunakan untuk menilai kesahihan kertas yang telah disaring. Jenis yang paling biasa ialah siri kes (n=5), diikuti dengan kawalan kes (n=4), laporan kes (n=3), dan keratan rentas (n=1). Kebanyakan artikel dikategorikan sebagai Tahap-IV (n=8), diikuti oleh Tahap-V (n=3), dengan hanya dua kajian diklasifikasikan sebagai Tahap-III (n=2) oleh kriteria Sackett. Saraf trigeminal dan vestibulocochlear telah ditunjukkan sebagai saraf kranial yang paling terlibat dalam Bell's palsy. Saraf optik, okulomotor, trigeminal, vestibulocochlear, glossopharyngeal, vagus, dan hypoglossal ialah tujuh saraf kranial yang berpotensi dikaitkan dengan Bell's palsy.

Kata kunci: anatomi klinikal, Bell's palsy, neuroanatomi, saraf kranial, saraf muka

ABSTRACT

Bell's palsy is characterised by one-sided lower motor neuron impairment of the facial nerve. Even though Bell's palsy is a peripheral facial nerve palsy, other cranial nerves should be investigated, because they are anatomically interconnected rather than isolated. The study aimed to look for evidence of other cranial nerves being involved in Bell's palsy. CINAHL, Academic Search Complete, MEDLINE, SPORTDiscus, and Scopus, all of which were updated until May 2021, were used to conduct a comprehensive search. Bell's palsy research focused on the origins and cause of the condition, regardless of study design, was eligible for inclusion. Animal research, non-English studies, grey literature, studies with no full text available, and those published in non-peer-reviewed journals, were excluded. While 3883 papers were found during the initial search, only 13 were included in the final study. The Joanna Briggs Institute Manual for Evidence Synthesis and Sackett's standard of evidence was used to assess the validity of the papers that were screened. The most common type was case series (n=5), followed by case-control (n=4), case report (n=3), and cross-sectional (n=1). Most of the articles were categorised as Level-IV (n=8), followed by Level-V (n=3), with only two studies classified as Level-III (n=2) by Sackett's criteria. The trigeminal and vestibulocochlear nerves are the most involved cranial nerves in Bell's palsy. The optic, oculomotor, trigeminal, vestibulocochlear, glossopharyngeal, vagus, and hypoglossal nerves are the seven cranial nerves potentially associated with Bell's palsy.

Keywords: Bell's palsy, clinical anatomy, cranial nerve, facial nerve, neuroanatomy

INTRODUCTION

Acute motor deficit affecting the same-sided upper and lower face muscles occur in patients with Bell's palsy, maximum within the first three days. Symptoms such as retro-auricular pain and ipsilateral face numbness are common (Prud'hon & Kubis 2018). Around 75% of patients can recover completely on their own; however, if oral corticotherapy is started within the first 72 hours, this rate can be increased. Adding an antiviral treatment has yet to be shown to be beneficial (Prud'hon & Kubis 2018).

Bell's palsy has been classically described to result in solitary unilateral facial nerve palsy manifested as one-sided facial weakness or paralysis (Tiemstra & Khatkhate 2007). Since the facial nerves also carry parasympathetic innervation to salivary glands and the lacrimal, secretions of tear as well as saliva are impaired on the affected side, resulting in dry eyes and dry mouth (De Seta et al. 2014). Nevertheless, patients may experience excessive lacrimation and pooling of the saliva on the affected side, due to loss of eyelid control and weakness of buccinator muscle (Tiemstra & Khatkhate 2007). The incidence of dry mouth resulting from reduced salivation from submandibular and sublingual glands is prognostic for a severe grade of paralysis in Bell's palsy (De Seta et al. 2014). Furthermore, because the chorda tympani branch of the facial nerve is involved in idiopathic Bell's palsy, there is a significant frequency of changed taste (De Seta et al. 2014; Tiemstra & Khatkhate 2007). Patients with facial nerve palsy have also been seen to develop paralysis of the stapedius muscle, which is innervated by the facial nerve's stapedial branch. Hypersensitivity to low-frequency sounds, also known as hyperacusis, may consequence as result from this (Heckmann et al. 2019).

At least 8% of the time, Bell's palsy appears to be linked to cranial nerve polyneuritis (Benatar & Edlow 2004). It's worth noting that a small but significant number of Bell's palsy patients also have additional cranial nerve problems. All Bell's palsy patients who presented to an emergency room over a two-year study period were evaluated. A total of 51 patients took part in the research (Benatar & Edlow 2004). Extracranial neuropathies were found in four of the individuals. Other cranial nerve involvement should never be assumed to be a symptom of Bell's palsy; therefore, it should always be studied further.

MATERIALS AND METHODS

Study Objective

International Platform of Registered Systematic Review and Meta-analysis (INPLASY) (Registration Number: INPLASY202160111) was used to register this study. In addition to the

facial nerve, this study seeked to explore other cranial nerve(s) co-involvement in Bell's palsy in a clinical case setting.

Study Identification

Five electronic databases, namely CINAHL, Academic Search Complete, MEDLINE, SPORTDiscus, and Scopus, were used to conduct a full systematic search. The initial searches were performed on 13th February 2020 and updated on 10th May 2021. The development of keywords arose from a discussion among authors and a review of existing works of literature (Adour et al. 1978; Benatar & Edlow 2004). The following keywords were used in the research: "Bell palsy" OR "Bell's palsy" OR "Facial Paralysis" OR "Cranial nerve palsy" OR "Facial nerve palsy" OR "Idiopathic nerve palsy" OR "Facial nerve paralysis" OR "Facial palsy" AND "Oculomotor nerve" OR "Trochlear nerve" OR "Abducens nerve" OR "Extraocular muscle" OR "Trigeminal nerve" OR "Mandibular nerve" OR "Olfactory nerve" OR "Optic nerve" OR "Vestibulocochlear nerve" OR "Glossopharyngeal nerve" OR "Vagus nerve" OR "Accessory nerve" OR "Hypoglossal nerve" AND "simultaneous" OR "concurrent" OR "coincid*" OR "concomitant" OR "involve*" OR "associat*" OR "connect*" OR "includ*" AND "human" OR "People" OR "homo sapiens" OR "patient*" OR "man" OR "men" OR "wom?n" AND NOT "animal*" OR "rabbit*" OR "mice" OR "mouse" OR "rat" OR "rabbit*" OR "monkey*" OR "pig*" OR "primate*" OR "dog*" OR "canine" OR "veterina*". Boolean operator, and other commands such as truncation, wildcards, exact and parenthesis were used whenever appropriate.

The reference list of the included study was screened manually via manual searches. Each of the discovered cases were cross-check for the availability of the original report. The screening process for eligibility was then performed after relevant citations were chosen.

Eligibility Criteria

The following inclusion and exclusion requirements, as developed by discussion among the authors, were applied to each retrieved study to determine its eligibility. The inclusion criteria were as follows: (i) any study investigating Bell's palsy; (ii) study in humans; and (iii) involvement of any cranial nerve(s). The final criterion was established by examining the other cranial nerve(s) that were discovered concurrently with Bell's palsy. The exclusion criteria were as follows: (i) animal studies; (ii) investigate nerve(s) other than cranial; (iii) intervention analysis; (iv) full text not available in English; (vi) grey literature (thesis, conference, book), and (vii) no full text available.

Study Selection

Duplicates were eliminated before the screening process. The first author (RA) assessed each title for eligibility according to the predefined criteria, followed by an independent screening

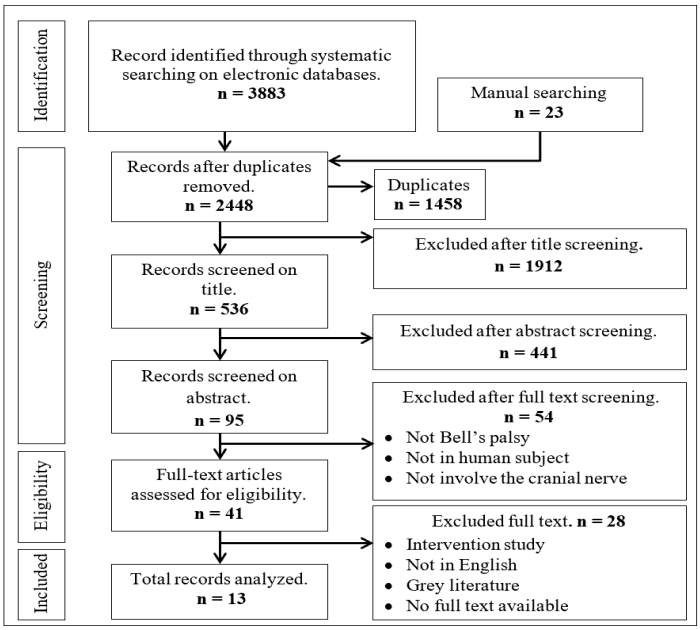

Figure 1: Screening Process

of the abstract and full text by all authors (RA, AA, MAK, WKH, SNHH, CKW, NFMN and MHR). The assigned authors double-checked all of the full texts. Any disagreements between the writers' decisions were resolved through discourse until an agreement was reached.

Data Extraction and Analysis

A narrative review of the articles was used in the final analysis. The research objectives, study design, clinical case setting, findings, cranial nerve(s) involved, and limitations were extracted from each paper and tabulated into a table. Cranial nerves other than the 7th were then identified during its clinical setting, which was based on the presenting symptoms and signs.

Quality Appraisal of the Study

The quality of screened articles was evaluated using the Joanna Briggs Institute Manual for Evidence Synthesis (Moola et al. 2017). Only case studies/reports, case series and case-control were found; therefore, quality evaluation forms for the two designs were selected. The case report evaluation form consists of eight items, while the case series and case-control were evaluated using the same evaluation form, which consisted of 10 items. For both forms, each item was rated either 'YES', 'NO', or 'UNSURE'. There was no total score calculated and each item was reported independently. At the end of the appraisal, overall evaluation was performed either to include, exclude or seek further info. RA and MHR administered quality assessments independently, which

Table 1: Summary of cranial nerves(s) involved in Bell's Palsy other than facial nerve. Only three of the five Sackett levels of evidence; Levels III, IV, and V, were appropriate for categorizing the final quest in this systematic analysis. At least one cranial nerve involvement has been linked to the onset of Bell's Palsy in thirteen studies. The trigeminal and vestibulocochlear nerves were involved in the majority of the cases, with each having six involvements. The optic and oculomotor nerves, on the other hand, are the least associated, with just one involvement each.

Sackett Level of Evidence (Level III)							
No	**Authors**	**Objective study**	**Study design**	**Setting**	**Findings**	**Cranial Nerve(s) involve**	**Limitations**
1	Tawfik, Walker, and Cartwright 2015	To compare the ultrasonographic features and parameters of facial nerve, vagus nerve and frontalis muscle between Bell's palsy patients and healthy individuals	Case-control	Twenty control patient and 12 patient with Bell's palsy were scanned for bilateral facial nerves, vagus nerves, and frontalis muscles using 18 MHz linear array transducer, from 1 week to 6.9 years interval of onset	Facial nerve and vagus nerve diameter was significantly larger in Bell's palsy patient compared to the control group (5.5 ± 1.6 mm^2), but not frontalis muscle. No percentage of the incidence was mentioned.	CN X (Average diameter in 6.7 ± 2.3 mm^2)	Small number of recruited subjects, lack of validity evidence of the tool used in the study, no recovery period was mentioned
2	McCandless and Schumacher 1979	To explain the audiologic features in facial paralysis compared to auditory nerve disorders	Case-control	Standard audiologic studies were used on a group of 58 patients with idiopathic facial paralysis for detection of concomitant cochlear nerve auditory dysfunction, from 6 hours to 10 years interval of onset	Only patients with a facial nerve lesion proximal to the stapedius branch had reduced tolerance for loud noises, reduced speech discrimination at high-intensity levels, and excessive loudness development	CN VIII (90% presented with hyperacusis)	Changes in auditory function can be a mechanical consequence of the absence of stapedial intervention

No	Authors	Objective study	Study design	Setting	Findings	Cranial Nerve(s) involve	Limitations
				Sackett Level of Evidence (Level IV)			
3	Esteban, De Andres, and Gimenez-Roldan 1978	An ocular electromyographic analysis was performed to corroborate the clinical findings of a gradual derangement in the physiological Bell's phenomenon in amyotrophic lateral sclerosis	Case-control	A clinical and electromyographic study of oculomotor function was carried out in a series of 24 patients with amyotrophic lateral sclerosis, from 3 to 66 months interval of onset	6 were classify as classic type, 10 cases as progressive bulbar palsy, and 8 cases belonged to the lumbar type. The mean duration of the illness was 16.7 months. 3 cases had severe limitation of voluntary upward movement and associated impairment of saccadic fixation on lateral gaze, together with spasmodic fixation and inability to close their eyes voluntarily with preservation of spontaneous and reflex blinking. 15 cases showed impaired bell's phenomenon of varying degree	CN III (62.5%)	No recovery period was mentioned
4	Adour et al. 1978	To analyze the nature of Bell's Palsy	Cross-sectional	Bell's palsy was diagnosed in 1048 of 1502 patients seen at the Facial Paralysis Research Clinic, no interval of onset was mentioned	Inflammation and demyelinization, rather than ischemic compression, may be the cause of motor cranial nerve dysfunction	CN V (19%), IX (19%)	No recovery period was mentioned
5	Rosenhall et al. 1983	To test the theory that the CNS is involved in Bell's palsy	Case-control	Thirty-one patients' auditory brain stem responses (ABR) were studied, all of the patients were seen within two weeks after the beginning of paralysis	ABR defects were observed in 9 of 31 patients with Bell's palsy, indicating auditory pathway dysfunction probably due to cochlear nerve dysfunction	CN VIII (29%)	No recovery period was mentioned
6	Hanner et al. 1987	To investigate the clinical effects of the CNS in patients with acute facial palsy	Case series	A total of 28 patients with acute unilateral facial palsy were studied, with a focus on clinical symptoms of CNS involvement within one week of the clinical presentation	Only 7 patients had unilateral facial nerve dysfunction during the acute stage, the remaining individuals, on the other hand, showed signs of a more widespread cranial nerves involvement	CN II (14.29%), V (89.29%), IX (7%), XII (3.57%)	After one year, no individuals with incomplete palsy who were in the acute stage of the disease showed permanent facial paralysis

No	Authors	Objective study	Study design	Setting	Findings	Cranial Nerve(s) involve	Limitations
				Sackett Level of Evidence (Level III)			
7.	Welkoborsky et al. 1991	To obtain Auditory-evoked brain-stem responses (ABR) recordings in patients with Bell's palsy	Case series	93 Bell's palsy patients underwent examinations, no interval of onset was mentioned	Presence of a neuropathy in both the auditory system and the facial tracts.	CN VIII (10.8%)	No recovery period was mentioned
8.	Benatar and Edlow 2004	To investigate symptoms of cranial neuropathy in patients with Bell's palsy	Case series	In two-year period,51 subjects with Bell's palsy who presented to an emergency department were included	8% of patients with Bell's palsy have additional cranial neuropathies	CN V (1.96%), IX (3.92%), XII (1.96%)	During the 6-week period, no one had had any additional neurologic problems
9	Lee et al. 2011	To describe the involvement of trigeminal nerve in patients diagnosed with Bell's palsy using the blink reflex (BR)	Case series	Blink reflex is elicited by the stimulation of supraorbital nerve on one side of the face, leading to two ipsilateral responses and one contralateral response in 28 patients, after 1 month of initial diagnosis	The ipsilateral response of BR was abnormal in average 94.6% of the patients, in addition, contralateral response was prolonged in 17.8% of the patients, indicating impaired trigeminal nerve function	CN V	1) Need to evaluate the prevalence of multiple cranial neuropathies and brainstem lesions 2) There is no correlation between BR response and facial nerve function 3) Extended period of follow-up visits is needed
10	Maller, Goldenstein, and Ronen 2018	Investigating of hearing loss in Bell's palsy patients	Case series	Audiology test of 24 Bell palsy's patients between 2004-2014	9 patients (37.5%) were in the group A (which has more 5dB of differences) and 15 patients (62.5%) were in the group B (the difference of 5 to -5dB). Group A has mean differences of 18.89 $\pm$ 9.28 dB and Group B has means of 3 $\pm$ 2.54 dB	CN VIII	No documentation on the cause of the paralysis and hearing loss, no recovery period was mentioned

No	Authors	Objective study	Study design	Setting	Findings	Cranial Nerve(s) involve	Limitations
				Sackett Level of Evidence (Level V)			
11	Shaikh et al. 2000	To report MRI findings of a patient with acute bilateral Bell's palsy	Case report	A 20-year-old man contracted an upper respiratory infection. One week later, left facial weakness and hyperacusis developed	Brain MRI revealed abnormal bilateral enhancement of the proximal intracanalicular segments of VII/VIII nerve complexes, after three months of corticosteroid treatment, he showed gradual improvement	CN VIII	Does not correlate with the severity and the neurologic outcome
12	Jiao et al. 2013	To describe the association of hemifacial spasm and trigeminal neuralgia in painful tic convulsion following ipsilateral Bell's palsy	Case report	A 77-year-old female underwent a microvascular decompression, who experienced Bell's palsy for the past half a year, adhesions were found after an incision to the dura mater.	The three-dimensional time-of-flight MRI indicated a deviation of the vertebrobasilar artery to the symptomatic side, cranial nerves VII and V were surrounded by an ectatic anterior inferior cerebellar artery, she was subsequently recovered after 21 months with no recurrence	CN V	-
13	Lagman et al. 2016	To report a patient with Bell's palsy symptoms and a cerebellopontine angle lipoma that was discovered by chance	Case report	Upon awakening, a 60-year-old woman had acute right-sided facial paralysis, facial asymmetry, decreased sensation of crude contact and hearing 2 days after diagnosed with Bell's palsy	Brain MRI showed other cranial nerves' involvement	CN V, VIII	No treatments option and outcome of the patients were clearly mentioned

were then verified through discussion.

For the evidence of quality in this systematic review, Sackett's hierarchy levels of evidence (Sackett 1989) was used. The evidence hierarchy has five levels: Level I (strong)-large randomized controlled trial with the clear cut result; Level II (moderate)-small RCT, other controlled trials; Level III (moderate)-cohort and case-control study; Level IV (weak)-case series or case-control study; and Level V (weak)-case report, studies with no control. Each study was classified into the hierarchy level based on the design. The use of evidence level is valid and useful to guide research application and indicates the trust and credibility of the evidence to be accepted in practice (Burns et al. 2011).

RESULTS

A total of 3883 articles were found, with 3860 found via electronic database searches and another 23 from the reference lists of the included studies, plus a list of related literature discovered using Google Scholar's "cited by" feature. After identifying duplication, 2434 publications were rejected, and only 13 individual studies were chosen after the screening procedure, as shown in Figure 1. Table 1 contains a description of each included individual study, as well as its relation to the cranial nerve(s). All research was categorised using Sackett's hierarchy levels of evidence, with each categorization following the year of publication in ascending order.

The Joanna Briggs Institute Manual for Evidence Synthesis was used to assess the quality of individual research, and the results are provided in Table 2. All articles that were chosen were grouped in the "included" section. Even though a few components had no 'YES' ratings, such as identifying adverse effects and reporting demographic information from the clinical presentation sites, most of the articles had clear clinical information, clear demographic characteristics, similar exposures to patients and controls, and acceptable statistical analysis, indicating high-quality literature.

Based on Sackett level of evidence, two case-control studies were categorized at Level III (Table 1) (McCandless & Schumacher 1979; Tawfik et al. 2015). The study demonstrated the enlargement of the vagus nerve in the symptomatic group compared to the healthy group by using neuromuscular ultrasound, even though this was insignificant. Nevertheless, the use of neuromuscular ultrasound as a tool for facial nerve assessment in this study was found to have low sensitivity. Moreover, evidence for the validity of the neuromuscular ultrasound -particularly the reliability and relations to other variables – were not established. Hence, further studies were required to provide the longitudinal measurements of the facial nerve parameters to confirm the findings. Furthermore, the involvement of the vestibulocochlear nerve was observed in standard audiologiy case-control studies of Bell's palsy patients.

Furthermore, eight studies were identified as Level IV. An ocular electromyographic evaluation was conducted to substantiate the clinical

Table 2: Summary of the quality of psychometric properties of the instruments. The Joanna Briggs Institute Manual for Evidence Synthesis was used to assess the quality of the articles that were screened. Each item on this form is assigned a 'YES', 'NO', or 'UNSURE'. At the conclusion of the appraisal, an overall evaluation was conducted to determine whether to include, exclude, or seek additional information.

Case Report	Shaikh et al. 2000	Jiao et al. 2013	Lagman et al. 2016
Were patient's demographic characteristics clearly described?	Y	Y	Y
Was the patient's history clearly described and presented as a timeline?	N	Y	N
Was the current clinical condition of the patient on presentation clearly described?	Y	Y	Y
Were diagnostic tests or assessment methods and the results clearly described?	Y	Y	Y
Was the intervention(s) or treatment procedure(s) clearly described?	U	Y	U
Was the post-intervention clinical condition clearly described?	Y	Y	Y
Were adverse events (harms) or unanticipated events identified and described?	U	N	U
Does the case report provide takeaway lessons?	U	Y	Y

Case Series	Hanner et al. 1987	Welkoborsky et al. 1991	Benatar & Edlow 2004	Lee et al. 2011	Maller et al. 2018
Were there clear criteria for inclusion in the case series?	Y	U	U	Y	Y
Was the condition measured in a standard, reliable way for all participants included in the case series?	Y	Y	U	U	U
Were valid methods used for identification of the condition for all participants included in the case series?	Y	U	U	U	Y
Did the case series have consecutive inclusion of participants?	N	U	N	U	N
Did the case series have complete inclusion of participants?	N	Y	U	U	Y
Was there clear reporting of the demographics of the participants in the study?	Y	U	N	Y	U
Was there clear reporting of clinical information of the participants?	Y	Y	Y	Y	Y
Were the outcomes or follow-up results of cases clearly reported?	Y	U	Y	Y	N
Was there clear reporting of the presenting sites'/clinics' demographic information?	U	N	U	N	U
Was statistical analysis appropriate?	U	Y	N	Y	Y

Case-Control	**Esteban et al. 1978**	**McCandless & Schumacher 1979**	**Rosenhall et al. 1983**	**Tawfik et al. 2015**
Were the groups comparable other than the presence of disease in cases or the absence of disease in controls?	N	U	Y	U
Were cases and controls matched appropriately?	N	N	U	N
Were the same criteria used for identification of cases and controls?	Y	Y	Y	U
Was exposure measured in a standard, valid and reliable way?	U	Y	Y	Y
Was exposure measured in the same way for cases and controls?	Y	Y	U	Y
Were confounding factors identified?	N	Y	U	U
Were strategies to deal with confounding factors stated?	N	Y	U	U
Were outcomes assessed in a standard, valid and reliable way for cases and controls?	U	Y	U	Y
Was the exposure period of interest long enough to be meaningful?	Y	N	Y	Y
Was appropriate statistical analysis used?	Y	Y	Y	Y
Cross-Sectional		**Adour et al. 1978**		
Were the criteria for inclusion in the sample clearly defined?		U		
Were the study subjects and the setting described in detail?		Y		
Was the exposure measured in a valid and reliable way?		U		
Were objective, standard criteria used for measurement of the condition?		U		
Were confounding factors identified?		Y		
Were strategies to deal with confounding factors stated?		U		
Were the outcomes measured in a valid and reliable way?		Y		
Was appropriate statistical analysis used?		U		

results of an aberration in the Bell's manifestation in amyotrophic lateral sclerosis revealing the involvement of the oculomotor nerve (Esteban et al. 1978). In addition, a disruption in voluntary oculopalpebral motions was discovered in a few patients.

With occurrences ranging from 5% to 20% of cases, auditory disorders with indications of idiopathic facial paralysis were common (Edstrom et al. 1984). In some cases, hearing function disturbance resulting from the impairment of the stapedius

muscle and due to central origin causes, vestibulocochlear nerve palsy (Welkoborsky et al. 1991). Another study reported pathological auditory-evoked brain-stem responses (ABRs) in 20% of Bell's palsy patients (Rosenhall et al. 1983). In addition, five articles showed involvement of six cranial nerves: optic, trigeminal, vestibulocochlear, glosopharyngeal, vagus and hypoglossal nerve (Adour et al. 1978; Benatar & Edlow 2004; Hanner et al. 1987a; Lee et al. 2011; Maller et al. 2018).

Finally, three studies were categorized under Level V. Of these, two case reports (Lagman et al. 2016; Shaikh et al. 2000) showed involvement of trigeminal and vestibulocochlear nerve during the incidence of Bell's phenomenon. Interestingly, both studies were using MRI to delineate the cranial nerve(s) involvement. The other case report study exhibited single cranial nerve involvement (trigeminal nerve) in a patient with painful tic convulsion following ipsilateral Bell's palsy (Jiao et al. 2013).

DISCUSSION

This review shows that in Bell's palsy, lower motor neuron palsy of the facial nerve coexists with other cranial neuropathies (Holland & Weiner 2004). Although Bell's palsy is classified as a mononeuropathy condition, clinical and epidemiologic reviews suggested that this condition is often presented with a myriad of clinical features that reflect mononeuritis multiplex or cranial polyneuritis (Holland & Weiner 2004; Adour et al. 1978). Distinguishing between polyneuropathy and facial nerve mononeuropathy in Bell's palsy is crucial, as these have implications for identifying the aetiology, developing a management plan, and determining the prognosis of the disease (Zhang et al. 2019; Lee & Lew 2019). It is important to generate an accurate diagnosis of unilateral facial paralysis as Bell's palsy, because this condition is benign, and may not require active intervention to resume the function of facial muscles (Brach & Vanswearingen 1999). On the other hand, other differential diagnoses such as cranial base and parotid gland tumours, which can also produce unilateral facial paralysis, require early detection and intervention, as these conditions may jeopardize the functions of facial and other cranial nerves permanently (Brach & Vanswearingen 1999).

Nonetheless, other cranial nerves were shown to be involved in this study, namely optic, oculomotor, trigeminal, vestibulocochlear, glossopharyngeal, vagus, and accessory nerves, in Bell's palsy cases. The patient diagnosed with acute myeloid leukaemia (AML) showed unilateral facial palsy with involvement of bilateral optic nerve in Lee et al. (2018). Furthermore, oculomotor function was affected by the alteration of Bell's phenomenon affected in patients with ALS (Esteban et al. 1978). Patients presented with either unstained upward displacement of the eyeballs upon closing the eyelids, absence of upward displacement of the eyeball or downward displacement of the eyes, a phenomenon of three degrees of altered Bell's. Hence, to rule out the 3rd cranial nerve involvement,

an electromyographic assessment of oculomotor function may be required.

Inflammation of the geniculate ganglion of the facial nerve is one of the recent postulations of Bell's palsy, which results in ischemia and demyelination of the nerve (Tiemstra & Khatkhate 2007). However, studies have shown that Bell's palsy patients with trigeminal dysfunction displayed evidence of brainstem involvement indicating central nervous system affection (Hanner et al. 1986). Likewise, central nervous system involvement was also reported in a patient with Bell's palsy with concurrent bilateral visual loss, which was due to the optic nerve infiltration by malignant cells (Lee et al. 2018). It was also noted that Bell's palsy patients with ophthalmic clinical conditions such as paralytic strabismus, diplopia, nystagmus, and limited extraocular muscles, had involvement of oculomotor, trigeminal, and trochlear nerve (Lee & Lew 2019). This polyneuropathic condition worsened the prognosis of the ophthalmic sign, and thus required special attention and management by the ophthalmologist (Lee & Lew 2019). Furthermore, the incidence of hyperacusis in Bell's palsy is commonly related to the involvement of the vestibulocochlear nerve, as some of the auditory fibres that are in proximity with the facial nerve are susceptible to changes in tone frequency (Lee & Lew 2019). This condition was in agreement with a finding of a previous study that reported smaller diameters and cross-sectional areas of the internal acoustic meatus – which was traversed by both facial and vestibulocochlear nerves – of the affected compared to the unaffected sides in Bell's palsy patients (Yilmaz et al. 2015). Acoustic reflexes are absent or abnormal in the majority of auditory nerve injuries.

Bell's palsy may occur as a result of reactivation of the herpes simplex virus (HSV) in acute benign cranial polyneuritis. In the cross-sectional study by Adour et al. (1978), the incidence of motor cranial nerve dysfunction (V and IX) was found to be attributable to inflammation and demyelination rather than ischemic compression. According to the findings of spinal fluid research, the condition appears to be a central nervous system phenomenon with secondary peripheral neural symptoms. The HSV may migrate to the chorda tympani in the geniculate ganglion via sensory neuron axon.

Furthermore, the majority of individuals with facial palsy complained of face skin irritation in the acute stage. Several patients' facial feelings had returned to normal when they were evaluated a few days later (Hanner et al. 1987b). The presence of sensory nerve fibres within the face of the skin may be an early component of the formation of facial nerve paresis could explain the temporary symptoms. However, as we discovered in our literature search, the most plausible explanation was caused by trigeminal nerve engagement. Clinical and neurophysiologic evidence backs this up. The facial discomfort, on the other hand, diminished as the facial nerve disease progressed (Hanner et al. 1987b). Other tests to elicit other cranial nerve involvement include

corneal reflex, vibration sense test, skin pin-prick test, and fundoscopic examination.

Besides, in patient with acute unilateral peripheral facial palsy, trigeminal dysfunction occurred as evidenced by the trigeminus-evoked potential test (TEP) and blink reflex test (BR), which are suggestive of trigeminal pathology with brainstem involvement and multifocal lesions (Hanner et al. 1986). The blink reflex test gives information on trigeminal and facial nerve functions in addition to electroneuronography (ENoG) results (Lee et al. 2011). This research suggests that in Bell's palsy, facial nerve dysfunction may be accompanied by subclinical trigeminal nerve involvement. Furthermore, the authors determined the severity and the extent of nerve involvement in Bell's palsy (Hanner et al. 1987b). Five individuals had an abnormal audiometry brainstem response (ABR), indicating that they had neuropathy in both the central auditory system and the facial tracts. This is in line with the findings of McCandless & Schumacher (1979). Patients with idiopathic facial paralysis due to a facial nerve injury proximal to the stapedius branch experienced the following clinical manifestations: (i) a decrease in loudness tolerance; (ii) a reduction in speech discrimination at high intensities; and (ii) an excessive increase in loudness as sound intensity increases.

In addition, 19 patients had aberrant ABR patterns due to high-frequency hearing loss alone (20.4%). Nevertheless, cochlear lesions have various clinical signs which are relatively non-specific. Audiometry brainstem response audiometry should be conducted on both ears within 6 weeks of the onset of the condition. Pure-tone and speech audiometry, as well as impedance audiometry, are all required (Yilmaz et al. 2015). A previous study postulated that a delay in the ABR and facial palsy share common pathophysiology in which neuropathy could occur in the central auditory and facial nerve pathways (Welkoborsky et al. 1991). To establish the evidence of CN VIII involvement, stapedial reflex recordings, pure-tone and speech audiometry, and temporal bone radiography were used. In addition, the amplitude of four ABR peaks was observed to be reduced in 14 patients with normal ABR readings (II, III, IV, V). All of the participants' audiometric thresholds were within normal ranges. Idiopathic facial palsy can occur in several stages, starting with inflammation and progressing to oedema and swelling of the facial nerve, extending proximally to the geniculate ganglion and internal auditory canal. This points to a cranial nerve VIII compression. A pioneered study that led to the understanding of bilateral idiopathic facial palsy through magnetic resonance (MR) images showed abnormal enhancement of proximal intracanalicular segments of cranial nerve VII/VIII complexes bilaterally, particularly in the leptomeningeal regions (Shaikh et al. 2000).

The term "interventional neuromuscular ultrasonography" refers to a variety of treatments used to diagnose and treat peripheral nervous

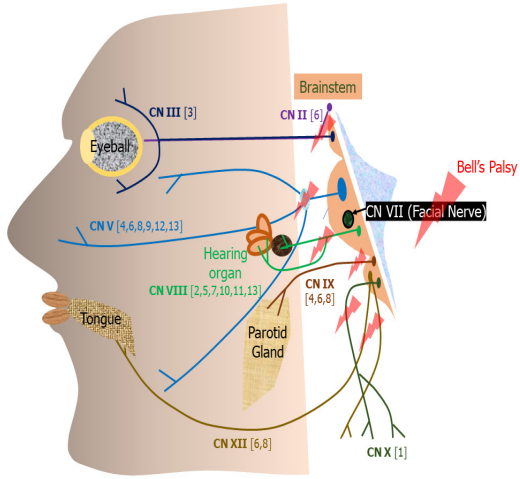

Figure 2: Cranial nerve(s) involvement in a patient with Bell's palsy. Seven cranial nerves (CN II, CN III, CN V, CN VIII, CN IX and CN X) were identified to be related to Bell's palsy. [1] Tawfik et al. 2015; [2] McCandless & Schumacher 1979; [3] Esteban et al. 1978; [4] Adour et al. 1978; [5] Rosenhall et al. 1983; [6] Hanner et al. 1987; [7] Welkoborsky et al. 1991; [8] Benatar & Edlow 2004; [9] Lee et al. 2011; [10] Maller et al. 2018; [11] Shaikh et al. 2000; [12] Jiao et al. 2013 and [13] Lagman et al. 2016.

system disorders. Recent advances in ultrasound resolution, as well as obstacles in electrophysiological cranial neuropathology evaluation, have advocated the use of neuromuscular ultrasound. The imaging of extracranial regions of cranial nerves VII and X using high-resolution ultrasonography revealed ultrasonographic characteristics in Bell's palsy. Serial sonographic scanning of the nerve from the commencement of the disease until recovery, as well as an evaluation of inter- and intrarater reliability, would all help this promising technique advance (Tawfik et al. 2015). Interestingly, this study also revealed unusual anatomical locations of the vagus nerve. In one cadaver, the nerve was discovered in the front section of the carotid sheath, while in another, a cervical lymph node was discovered near to the nerve, implying that facial palsy is linked to a more widespread polyneuropathy.

Thus, patients with Bell's palsy require detailed neurological examination of other cranial nerves as this information would lead to detection of cause and site of the lesion (Wormald et al. 1995). Even though the aetiology of Bell's palsy is classically documented as idiopathic, this diagnosis is by exclusion, and so elimination of other potential etiologies of Bell's palsy is pertinent (Zhang et al. 2019).

During the screening procedure, a few information gaps were discovered. Laterality manifestations of the cranial nerves lesion, whether ipsilateral or contralateral, were less well described. Furthermore, the findings of each study did not specify whether the nervous system was sensory, motor, somatic or autonomic. On the other hand, the majority of the less-experienced neurologists who initially recognized

and followed up on their Bell's palsy patients may miss the identification of other cranial polyneuropathy involvement. Some investigations also had a small number of respondents and a lack of proof of the tools' validity. Furthermore, several investigations found no link between the severity of cranial neuropathy involvement and neurologic prognosis, hence limiting the findings. The occurrence of Bell's palsy was likewise limited when the brainstem lesion was less evaluated with the frequency of several cranial neuropathies. Finally, the effects of the COVID-19 pandemic may have influenced the attendance of follow-up patients in the clinic, resulting in a reduction in undetected cranial polyneuropathy cases.

CONCLUSION

According to our results, various cranial nerve co-involvement might occasionally occur in conjunction with an otherwise usual idiopathic facial neuropathy (Bell's palsy) (Figure 2). Following the screening process, thirteen studies were chosen. Among the seven potential cranial nerves associated with Bell's palsy are the optic, oculomotor, trigeminal, vestibulocochlear, glossopharyngeal, vagus, and hypoglossal nerves. The trigeminal and vestibulocochlear nerves were found to be the most involved cranial nerves. Notably, evidence of other cranial nerve involvement was discovered in a small but considerable number of Bell's palsy patients. We do not want to imply that polyneuritis cranialis is always linked to Bell's palsy, but we do think that such cases should be extensively investigated. As a result, Bell's palsy patient needs a comprehensive neurological examination of extracranial nerves to ascertain the cause and location of the lesion.

ACKNOWLEDGEMENT

This systematic review's protocol was registered on INPLASY (INPLASY202160111) and is available in full at http://inplasy.com/INPLASY202160111. Because no human volunteers were engaged, there was no need for an ethical evaluation of this study.

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Received: 18 Nov 2021
Accepted: 03 Jan 2022