FACULTY OF HEALTH SCIENCES PHYSIOTHERAPY AND BEAUTY THERAPY DEPARTMENT

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THE EFFECTIVENESS OF MANUAL PHYSIOTHERAPY TECHNIQUES AND ACTIVE PHYSIOTHERAPY APPROACH FOR PREVENTING AND TREATING SYNKINESIS IN ADULT PATIENTS WITH BELL'S PALSY: LITERATURE REVIEW

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SUMMARY

Larisa Matvejeva ’’The effectiveness of Manual Physiotherapy Techniques and Active Physiotherapy Approach for preventing and treating Synkinesis in adult patients with Bell’s Palsy'' systematic literature review, Supervisor Doc.dr Julija Andrejevsa, Physiotherapy Study Programme, Faculty of Health Science, Klaipeda State University of Applied Sciences, Klaipeda, 2022.

Research problem. One significant sequela of facial nerve palsy is synkinesis. Synkinesis causes involuntary movements during voluntary action. This dysfunction can significantly impact patients' lives, limiting their ability to enjoy eating and talking, which has psychosocial effects. Currently, there are several versions of the etiology of synkinesis. Each of them has a right to exist, as evidenced by multiple studies. But what has already been proven accurately and reliably is that synkinesis arises due to the consequences of facial paralysis. In this thesis, synkinesis is regarded as a consequence of Bell's Palsy in adults. Since Synkinesis is a consequence of this neurological disorder, the treatment and rehabilitation of the underlying condition should first be considered to prevent the onset of these consequences. Bell's Palsy & synkinesis management involves a multidisciplinary approach, including several professionals such as medical doctors and physiotherapists. Previous studies have advocated treatment using physiotherapy modalities alone or with exercise therapy, but no consensus exists on the optimal approach. Thus, this review summarizes controlled clinical studies in the management of synkinesis in facial nerve palsy. This systematic review aims to identify available manual techniques and active physiotherapy approaches for Bell's Palsy management and their effects on synkinesis.

Research object. Manual physical therapy techniques and active physical therapy approaches and their impact on the prevention and treating of synkinesis in adults with Bell's palsy.

Research aim. To evaluate different manual physical therapy techniques and active physical therapy approaches and their impact on the prevention and treating of synkinesis in adults with Bell's palsy.

Research tasks.

1. To overview the scientific literature and describe the VII Cranial nerve anatomy, physiology and functions features, Bell’s Palsy aetiology, epidemiology, assessment and management. Synkinesis aetiology, epidemiology, assessment and management

2. To determine the effect of manual physiotherapy technique and active physiotherapy aproach for preventing and treating and synkinesis prevention in Bell’s Palsy adults.

Research method. Analysis of scientific literature, systematic literature review.

Conclusions. After systematic literature analysis, it has been noticed that Bell's Palsy is the most common cause among idiopathic unilateral facial palsy cases,60–75%.worldwide. More common in pregnant women, people with diabetes, obesity, hypertension and upper respiratory ailments. The cause of Bell's Palsy remains unknown, although the disorder is polyneuritis with possible inflammatory, viral, ischemic, and autoimmune etiologies. Synkinesis is the most often sequel of Bell" s Palsy.

The most effective way to prevent and treat synkinesis in Bell's Palsy adults can be NeuroMuscular re-education. This method can be represented with different techniques, such as mirror, PNF Proprioceptive Neuromuscular Facility, PIR, massage and classic facial streching exercises ,carried out according to the principle of feedback. Techniques such as mirror therapy, Proprioceptive Neuromuscular Facility and other feedback techniques can be defined as manual techniques, can be by active physiotherapy approach, depending on the ways of applying. . Muscle-strengthening exercises are a place to be, but only in the first- second stages of Bell's Palsy. When synkinesis appears, the application of this type of exercise has not to effect or can make it worse. However, still, one must understand that all these methods should be combined with drug therapy, possibly surgical intervention, for a better result.

Keywords: Bell’s Palsy, Facial palsy, synkinesis, physiotherapy, rehabilitation.

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GLOSSARY

BUC buccinators	***FN*** facial nerve
COM compressor naris	***H.B*** House-Brackmann facial nerve grading
COR corrugator	***PFP*** peripheral facial paralysis
DAO depressor anguli oris	***MS*** muscle strengthening intervention
DIN dilator naris	***Non-MS*** without muscle strengthening intervention
DLI depressor labii inferioris	***SMCI*** selective muscle contraction intervention
FRO frontalis	***NMR*** Neuromuscular reeducation
LAO levator anguli oris	***ES*** Electrical stimulation
LLA levator labii alaeque nasi	***FDI*** Facial Disability Index
LLS levator labii superioris	***HBS*** House Brackman Scale
MEN mentalis	***FDI-P*** Facial Disability Index- Physical Score,
OCI orbicularis oculi inferioris	***FDI-S*** Facial Disability Index-Social Score,
OCS orbicularis oculi superioris	***MVF*** Mirror Visual Feedback
OOI orbicularis oris inferioris	***p-value*** probability.
OOS orbicularis oris superioris	***NMR (NRE)*** Neuromuscular Re-Education
PLA platysma	***PNF*** Proprioceptive, Neuromuscular Facility
PRO procerus	***HFS*** Hemifacial spasm is a neurological disorder that appears as involuntary contractions of the eyelids and other facial muscles with twitching of the face on that side (Baylor College of Medicine, 2021).
RIS, risorius	
ZYJ zygomaticus major	
ZYN zygomaticus minor	

INTRODUCTION

Facial paralysis is a fairly common manifestation in general medical practice. The facial nerve is a fundamental structure for both emotion and communication, and therefore functional impairment can significantly impair quality of life. Most often, the cause of facial paralysis remains unknown and is called Bell's palsy and has an incidence of 10 to 40 per 100,000 (Walker, Mistry & Mazzoni, 2020). Bell's palsy can also be defined as an acute unilateral paralysis of the lower motor neurons of the facial nerve that resolves gradually over time in 80–90% of cases (Bell Palsy: Practice Essentials, Background, Anatomy, 2020). Facial expression is essential to a person's perception of well-being and the ability to integrate into social networks. Therefore, the psychological burden of patients with facial paralysis is unbearably heavy. With pronounced asymmetry of the face and decreased facial movements, some patients with paresis become depressed, and some experience stress and despair. Moreover, of course, such people try to avoid crowded places and interpersonal relationships (Zhang et al., 2019). Facial Synkinesis is one of the most unpleasant and complex consequences of facial paralysis, which leads to impaired facial movements, abnormal facial expressions and, as a result, social isolation. However, the primary mechanism of post-paralytic facial Synkinesis remains unclear and not fully understood (HUANG, WANG & DING, 2021). Facial Synkinesis is part of the aftermath of Bell's palsy. These involuntary, uncoordinated movements of the facial muscles mimic led to aesthetic and functional disorders leading to decreased quality of life. Limit the patient's ability to drink, eat, display facial expressions and articulate. Functional, social and psychological dependence of people on the manifestation of facial Synkinesis forces us to find new ways and solutions for the timely detection and treatment of this disorder in patients suffering from Bell's paralysis (Shokri et al., 2021).

The novelty and relevance of the study. The widespread occurrence of the novel coronavirus disease (COVID-19) and the associated acute respiratory syndrome coronavirus 2 (SARS-CoV-2) has led to reported cases of FPI. Some cases of IFP have been identified, and the cause has been linked to vaccine trials. One study found 7 cases of Bell's palsy among 40,000 participants in the vaccination group. Based on this frequency ratio of approximately 7:0, it is suggested that vaccination is possibly associated with Bell's palsy ($p = 0.07$) (Bell Palsy: Practice Essentials, Background, Anatomy, 2020). In pneumonia cases in Wuhan, China city, a new coronavirus was identified as the cause at the end of 2019. Since then, it has spread rapidly, and the number of cases has increased worldwide (Zhu et al., 2020). In February 2020, the World

Health Organization (WHO) designated the viral disease as COVID-19, which stands for coronavirus disease 2019. Neurologic complications are known to occur in 36.4% of COVID-19 patients (Mao et al., 2020). Several cases of Guillain-Barré syndrome (GBS) post-COVID-19 has been reported), some of which have a complication such as facial nerve palsy (Toscano et al., 2020; Zhao et al., 2020; Juliao Caamaño & Alonso Beato, 2020).

Research problem (questions). What are the manual physiotherapy technique and active physiotherapy approaches available for complex treatment and rehabilitation in the presence of the Bell's Palsy in adult patients? What are their effects on preventing and treating Synkinesis in the presence of the Bell's Palsy in adult patients?

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1.THEORETICAL PART

1.1 Cranial nerves anatomy and physiology

Nerves are a layered structure with a shiny hard grey outer periosteal layer, and another layer directly below this one covers the epineural layer of the nervous tissue and is formed by the choroid plexus. On the periphery of this vessel, the plexus is formed by the stylomastoid artery and is replaced by a petrosal branch of the middle meningeal artery, internal auditory artery and anterior inferior cerebral artery more centrally (Zhang et al., 2019). The facial nerve has the motor and sensory fibers. Motor axons innervate the facial muscles and also the stapedius muscle. Parasympathetic fibers go to the ganglia that innervate the lacrimal and oral glands. The sensory component provides innervation to the external auditory canal, auricle, and tympanic membrane and will also carry taste sensations from the anterior two-thirds of the tongue (Dulak & Naqvi, 2020). Cranial nerve VII, the facial nerve carries secretory, motor, and afferent fibres from the anterior two-thirds of the tongue. It originates in the facial nucleus, located in the caudal region of the pons. Corticobulbar fibres from the frontal lobe and precentral gyrus are projected to the nucleus of the face, while the majority of them pass to the contralateral side. The result is that uncrossed and crossed fibres are found in the nucleus (“Facial Nerve Paralysis: Overview, Anatomy, Pathophysiology,” 20210). The facial nucleus is distributed into two parts: the one that receives the corticobulbar processes bilaterally, then goes to the upper parts of the face, including the forehead - the upper part, and the second-lower part, the primary intersecting projections of which innervate the lower muscles of the face (the posterior belly of the digastric, stylohyoid, platysma and buccal) (Heckmann et al., 2019).

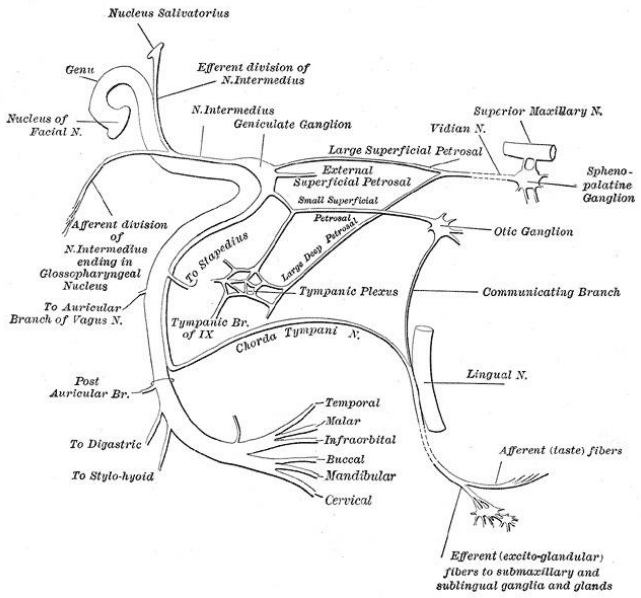


Figure 1. The map of the facial and intermediate nerves; relationship with other nerves

(“Facial Nerve Paralysis: Overview, Anatomy, Pathophysiology,” 2021)

Special visceral efferent (SVE) fibers are a main part of the facial nerve. Their work is to innervate the muscles of facial expression: the stylohyoid muscle, the posterior belly of the digastric muscle and the stapedius muscle. The neurons of these fibers reside in the facial nucleus in the caudal pontine tegmentum. From the facial nerve to the greater petrosal nerve and the chorda tympani nerve, General visceral efferent (GVE) leaves fibers (parasympathetic preganglionic motor fibers). After synapses formation in the pterygopalatine ganglion, the greater petrosal nerve procures postganglionic parasympathetic innervation to oral, nasal, and palatine glands. The greater petrosal nerve provides the lacrimal gland by giving branches to the zygomatic branch of the maxillary nerve. After that moves from the lacrimal nerve to the lacrimal gland, these postganglionic fibers cause secretion and vasodilation in the lacrimal gland. The chorda tympani synapses in the submandibular ganglion and later with GVE travel as the lingual nerve, a branch of the mandibular nerve. The lingual nerve reaches the submandibular and sublingual glands, where the GVE fibers cause stimulating secretion and vasodilation. GVE preganglionic neurons reside in the superior salivatory nucleus in the brain stem (Dulak & Naqvi, 2020; Medscape.com, 2019).

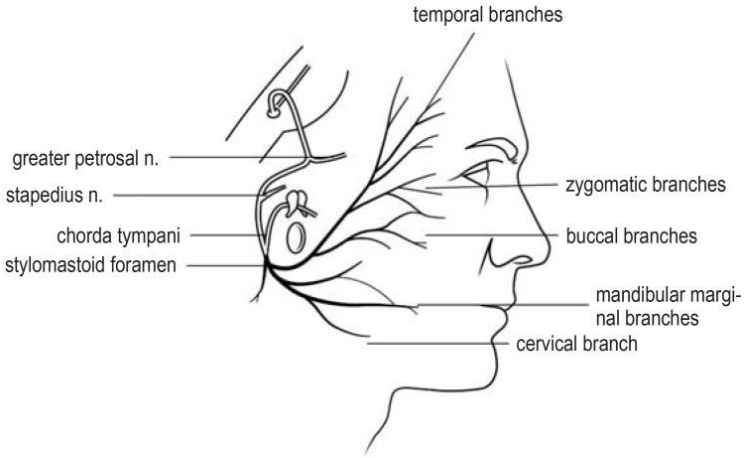


Figure 2. Course and branches of the facial nerve (BL. Heckmann et al., 2019).

In 1550, Fallopius noted a narrow opening in the temporal bone through which part of the seventh cranial nerve (facial nerve) passes; it is also sometimes called the fallopian canal or the facial canal. The difference between the fifth and seventh cranial nerves: is that the seventh nerve is mainly involved in the motor function of the face, and the fifth nerve, from the very beginning, primarily conducts sensation. In 1828, Charles Bell noted (Bell Palsy: Practice Essentials, Background, Anatomy, 2020; Heckmann et al., 2019; Dulak & Naqvi, 2020). The facial nerve includes parasympathetic fibers that run to the palate, nose and lacrimal glands in a tortuous course in the center and on the periphery. The facial nerve passes the 30 mm intraosseous system through the internal auditory meatus, the eighth cranial nerve through and through the inner uterine canal in the petrous temporal bone. This bony restriction does not allow the nerve to swell before it compresses. The facial nerve nucleus lies in the reticular formation of the bridge adjacent to the fourth ventricle. The facial nerve roots include motor, salivary and solitary fibers. The preganglionic parasympathetic fibers of the salivary nucleus are connected to the fibers of the solitary nucleus, forming the intermediate nerve. The intermediate nerve includes sensory fibers that run from the tongue, mucous membrane, skin behind the ear, and parasympathetic fibers to the lacrimal and salivary glands. These fibers then form synapses with the submandibular ganglion, which has fibers innervating the sublingual and submandibular glands. The intermediate nerve also provides the pterygopalatine ganglion, parasympathetic fibers that innervate the lacrimal glands: nose and palate. The facial nerve fibers then pass around the nucleus of the sixth cranial nerve and exit the pons at the cerebellopontine angle, where they pass through the internal auditory meatus and the vestibular portion of the eighth cranial nerve. The facial nerve runs

through terminates in the zygomatic and the stylomastoid foramen in the skull, buccal, mandibular, and cervical branches. These nerves serve the facial muscles, including the frontalis, orbicularis oculi, buccal, platysma, and orbicularis oculi muscles. Other muscles innervated by the facial nerve are the stapedius, stylohyoid, posterior belly of the digastric, occipital, anterior and posterior auricular muscles. All muscles innervated by the facial nerve arise from the second-gill arch (Facial Nerve Paralysis: Overview, Anatomy, Pathophysiology, 202; Bell Palsy: Practice Essentials, Background, Anatomy, 2020; Medscape.com, 2019).

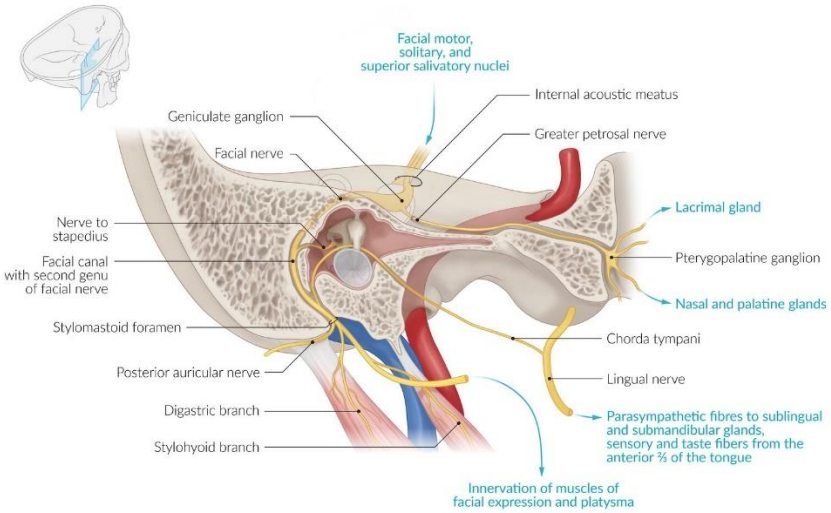


Figure 3. Course and branches of the facial nerve (VII). The oblique cut of the right petrous temporal bone exposes the course of the facial nerve (Amboss.com, 2022)

1.1.2 Facial muscles anatomy and physiology

Mimic muscles are responsible for the expression of emotions by changing facial expressions. Task the anterior belly of the digastric muscle, together with the posterior belly of the digastric muscle, lifts the hyoid bone and is also involved in all complex jaw movements. The stylohyoid muscle has a different purpose; it pulls the hyoid bone back, which causes a swallowing action and raises the tongue. The stapedius muscle of the middle ear protects and stabilizes the stapes by preventing movement in response to loud sounds (Dulak & Naqvi, 2020).

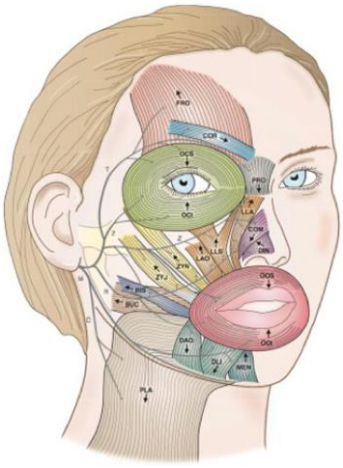


Figure 4. Muscles of facial expression. Muscles of facial expression; arrows indicate the directional vector of muscle contraction (Shokri et al., 2021).

The facial muscles and their functions: Procerus – is a frown muscle. ***Orbicularis oculi*** – the eye's circular muscle closes the eyelids and squints the eye. These two muscles are antagonists. ***The Frontalis muscle*** makes horizontal forehead wrinkles when we are surprised and lifts the eyebrows. ***Zygomatic muscles (major and minor) raise*** the mouth corners up and outward when we smile. ***Depressor anguli oris*** pulls mouth corners downward. ***Corrugator superclii*** draws eyebrows together. ***Risorius, this is*** the "smile" muscle. This muscle is not active in some people. Pulls mouth corners laterally and forms dimples in the cheeks. ***Orbicularis oris*** the circular muscle of the mouth. Brings mouth corners towards the middle line. Puckers the lips. ***Depressor anguli oris*** pulls mouth corners downward. ***Levator labii superioris*** and ***depressor labii inferioris*** pull the upper and lower lips up and down when we grin. ***Mentalis*** the chin muscle, which pulls up the chin as we express disappointment, doubt, and other negative emotions. ***Platysma*** is a superficial muscle on the neck (Crystal Touch Bell’s Palsy Clinic, 2019).

1.2 Bell’s Palsy

Facial paralysis is the complete (paralysis) and/or partial (paresis) loss of function of the facial nerve (cranial nerve VII). The most common cause can be safely called Bell’s palsy: idiopathic peripheral facial paralysis. Other causes may be related to brainstem stroke, trauma, tumors, infections, and metabolic disorders (Amboss.com, 2022; Facial Nerve Paralysis: Overview, Anatomy, Pathophysiology, 2021). Bell's palsy, also known as idiopathic facial paralysis (IFP), is the most common cause of unilateral facial paralysis and the most common neurological disorder of the cranial nerves. As a rule, Bell's palsy gradually disappears over time, but its cause is still unknown (Bell Palsy: Practice Essentials, Background, Anatomy, 2020). Bell's palsy is an idiopathic form of facial paralysis. One theory of etiology is caused by edema due to a viral infection. Bell's palsy differs from other causes of facial palsy in that it starts quickly and progresses within hours without injury or apparent cause. In addition, this type of facial paralysis very often goes away, and recovery occurs within a few days or weeks (Dulak & Naqvi, 2020).

1.2.1 Epidemiology, etiology and pathogenesis

Facial nerve palsy/paresis and Idiopathic, Acute palsy/paresis (Bell’s Palsy)

The most common neurological disorder is Bell's palsy, which affects the cranial nerves and is one of the most common causes of facial paralysis globally—calculated that it accounts for an average of 60-75%acute unilateral facial paralysis cases. Bell's palsy is more commonly diagnosed in pregnant women and people with diabetes. The annual incidence statistic of Bell's palsy in the United States is around 23 cases per 100,000 people. Fewer cases are observed in the summer. The highest incidence rate was found in a 1986 study in Sekkori, Japan, and the lowest was in a 1971 study in Sweden. As a Rule, most population-based studies typically find an annual incidence of 15–30 cases per 100,000 population. Bell's palsy accounts for approximately 60–75% of acute unilateral facial paralysis cases, of which the right side is affected in 63% of cases. Bilateral simultaneous Bell's palsy can develop, but this is rare, accounting for only 23% of bilateral facial palsy (Bell Palsy: Practice Essentials, Background, Anatomy, 2020). Of the diseases of the cranial nerves, the most common is Paralysis of the facial nerve. Bell's palsy, its idiopathic form, accounts for 60–75% of cases. There are 7-40 cases per 100,000 people per year. The incidence in both men and women is the same. Higher in pregnant women, lower in children (Heckmann et al., 2019).

Gender and age demographics. Bell's palsy is more often seen in adults. A slightly significant predominance is observed in patients over 65 years of age, with an average of 59 cases per 100,000 population. Less Bell's palsy occurs in children under 13 years of age (approximately 13 cases per 100,000 population). It can be summarized that the lowest incidence is observed in persons younger than ten years old, and the highest - is in persons aged 60 years and older. The peak age is 20 to 40 years old. Discussions about the etiology and treatment of Bell's palsy have been going on for a long time. The cause of Bell's palsy remains unknown, but it may be defined as a polyneuritis disorder with possible viral, autoimmune, inflammatory, and ischemic etiologies. More and more data can be found on the reactivation of herpes simplex virus type I and herpes zoster virus from cranial nerve ganglia (Bell Palsy: Practice Essentials, Background, Anatomy, 2020). The possible etiology of BP that has been proposed is infection with reactivated viruses such as a herpes simplex virus type 1 (HSV-1), varicella-zoster virus (VZV), and human herpesvirus and usutu virus (Zhang et al., 2019).

Viral and bacterial infection etiology. In the past, situations caused by exposure to cold, such as cold winds, a cold air conditioner, or driving a car with an open window, were thought to be the only triggers for Bell's palsy. Similarly, some authors now consider herpes simplex virus (HSV) the most common cause of Bell's palsy, although there is a causal relationship between HSV and Bell's palsy. The current hypothesis that HSV is the etiological agent of Bell's palsy determines that after a primary infection on the lips, such as herpes, the virus travels up the axons of sensory nerves and remains in the geniculate ganglion. When under stress, the virus reactivates and causes local damage to myelin. This hypothesis was first proposed in 1972 by McCormick after an autopsy of a patient with Bell's palsy had HSV in the geniculate ganglion. Murakami et al. analyzed the endoneurial fluid of the facial nerve in patients undergoing surgery for Bell's palsy and found HSV in 11 of 14 cases. In support of a viral etiology, there have been findings where an intranasal inactivated influenza vaccine was strongly associated with the development of Bell's palsy. However, it remains unclear whether the other component of the vaccine caused paresis, which was then accompanied by reactivation of HSV infection (Bell Palsy: Practice Essentials, Background, Anatomy, 2020***).*** Viral etiology (from 4.5 to 7%) - Herpes Zoster infection due to ganglionitis of the geniculate body, called Ramsay-Hunt syndrome (RHS). The virus remains at rest in the geniculate ganglion, which receives innervation from the glossopharyngeal nerve (CN IX). However, activating the virus can cause a prodromal period of otalgia and vesicular eruptions on the soft palate and external auditory canal. Acute otitis media can cause the sutures in the facial canal to separate, leading to nerve palsy, necrotizing otitis externa, and cholesteatoma. Sometimes the cause of facial paralysis is Lyme disease; symptoms are similar to a tick bite, erythema

migrants, headache and fatigue, sometimes arthritis and heart damage: myopericarditis (Walker, Mistry & Mazzoni, 2020). Bell's palsy is also known to follow a recent upper respiratory infection (URI). Bell's palsy can be about viral and autoimmune reactions and cause demyelination of the facial nerve, which leads to unilateral facial paralysis. For the development of Bell's palsy Impact of COVID-19 infection and SARS-CoV-2 vaccine Viruses and vaccinations have been identified as risk factors. Idiopathic facial paralysis (IFP) has been reported associated with COVID-19 and SARS-CoV-2 and currently available vaccines. The specific risk associated with vaccines against COVID-19, SAR-CoV-2 and SARS-CoV-2 has not yet been determined. In addition to HSV infection, there may be other infections, such as Lyme disease, syphilis, herpes zoster, Epstein-Barr virus infection, cytomegalovirus, mycoplasma, human immunodeficiency virus [HIV], inflammation itself; and microvascular diseases such as diabetes mellitus and hypertension. People with diabetes have a 29% higher risk of developing Bell's palsy than people without diabetes, and people with this diagnosis are more likely to have Bell's palsy recurrence (Bell Palsy: Practice Essentials, Background, Anatomy, 2020; Walker, Mistry & Mazzoni, 2020; Facial Nerve Paralysis: Overview, Anatomy, Pathophysiology, 2021). By July of the 2020 year, 19 patients (six women) with Guillain-Barré syndrome or its variants and COVID-19 have been enrolled with a mean age of 63 years. Given the number of SARS-CoV-2 infections worldwide. Neurological symptoms began an average of -7 to 24 days after respiratory or systemic symptoms. 11 patients had Guillain-Barré syndrome with weakness in all four limbs with or without sensory loss. Three had a paraparesis with weakness in the legs, and one had lower limb paresthesia. Four of these patients had facial nerve involvement, five had dysphagia, and eight developed respiratory failure. Three had autonomic complications, one had hypertension, and two had sphincter dysfunction. Some Electrophysiological studies were performed on 12 patients, and indeed, they confirmed the presence of demyelinating disease in eight and axonal disease in four patients. One patient had bilateral, and one patient had unilateral abducens paralysis. Two patients had a variant of Guillain-Barré Miller-Fischer syndrome with ophthalmoplegia, ataxia, and areflexia; increased creatine kinase levels provoked Muscle damage, which was observed in 23 (11%) of 214 patients in the Wuhan study. Loss of smell (anosmia) and taste (ageusia) have become common symptoms of COVID-19, either along with other signs or in isolation. A study of 259 patients, 88 including 68 who tested positive for SARS-CoV-2, found that abnormal smell and taste were strongly associated with COVID-19. In a European study50, olfactory dysfunction was reported in 357 (86%) of 417 patients with COVID-19; 342 (82%) reported taste disturbances. These symptoms were reported more frequently in patients with COVID-19 than in a cohort of patients with a history of influenza.89 Subclinical disturbances in smell, taste, or both have also been found.

However, these symptoms may occur with any respiratory infection due to acute rhinitis. The fact that they occur in isolation from other symptoms suggests the involvement of the olfactory nerve (Ellul et al., 2020).

Trauma (10 to 23%). Facial wounds cross the facial nerve branches, and fractures of the petrous part of the temporal bone can cause facial paralysis. Moreover, iatrogenic injuries during surgery can lead to traumatic injuries to the temporal bones and sprains of the facial nerve (Walker, Mistry & Mazzoni, 2020).

Neoplasia (2.2 to 5%). Facial and acoustic neuromas, parotid malignancies, meningioma and arachnoid cysts lead to facial paralysis; the symptoms of paralysis appear slowly and in different ways due to the tumor’s location (Walker, Mistry & Mazzoni, 2020).

Hereditary etiology. A family history of Bell's palsy has been reported in about 4% of cases. Inheritance may be autosomal dominant with low penetration, but predisposing factors are still inherited. Siblings may also have a family history of diseases of other nerves, nerve roots, or plexuses, such as trigeminal neuralgia. In addition to all this, there are some reports of Bell's palsy with neurological disorders, including ophthalmoplegia and essential tremor. A rare form of familial Bell's palsy is more common and severe in underage girls (Bell Palsy: Practice Essentials, Background, Anatomy, 2020).

According to the latest data from an article published in February 2022 on the Online Medical Education Platform (AMBOSS), the authors adhere to this version of the etiology: Idiopathic peripheral facial palsy ‘’ Bell’s’ ’Palsy. Infection. Trauma. Borreliosis (Lyme disease). Herpes zoster (Ramsay Hunt syndrome). HIV. HSV reactivation. Tumors (parotid gland tumors, acoustic neuroma). Malignant otitis externa. Diabetes mellitus. Sarcoidosis (Hereford syndrome). Amyloidosis. Pregnancy. Guillain-Barré syndrome. Stroke. (Amboss.com, 2022). Several possible risk factors for BP include severe preeclampsia, glucose metabolism abnormalities, radiation exposure, psychological factors, migraine and hypertension. Latest epidemiological studies added to the known list of reasons for BP are also related to extreme temperature exposure (Zhang et al., 2019).

Pathophysiology. Until now, the exact pathophysiology of Bell's palsy remains controversial. The facial nerve passes through a portion of the temporal bone, commonly referred to as the facial canal. The most popular theory suggests that oedema and ischemia compress the facial nerve in this bony canal, but the cause of oedema and ischemia is still not known. The first part of the facial canal, the labyrinth segment, is the narrowest; the diameter of the meatal opening in this segment

is about 0.66 mm. This place is considered the most commonplace with Bell's palsy, where the facial nerve is compressed. Since the facial canal has narrow boundaries, it seems evident that inflammatory, ischemic, demyelinating, or compression processes can disrupt nerve conduction in this particular place. In the diagnosis of Bell's palsy, the facial nerve lesion is peripheral to the nerve nucleus. Therefore, it is believed that the damage occurs near the geniculate ganglion or in itself. The same effect occurs with damage between the crankshaft and the beginning of the drum string; the exception is that it does not cause lacrimation. However, if the lesion is in the stylomastoid foramen, it can only lead to facial paralysis (Bell Palsy: Practice Essentials, Background, Anatomy, 2020; Facial Nerve Paralysis: Overview, Anatomy, Pathophysiology, 2021). Ample evidence suggests that BP leads to acute inflammatory demyelination. First, some evidence supporting this etiology is supported by histological changes in the facial nerve, first identified by Liston and Kleid, whose characteristics are summarized next. Nerve from the internal auditory meatus passage into the stylomastoid foramen, infiltrated by round, small inflammatory cells, Destruction of myelinated neurons sheath in which macrophages are involved, Intraneuronal space is enlarged, bony uterine canal Usually, there are no signs of compression of the facial nerve (Zhang et al., 2019).

Facial paralysis is already fully manifested within the first 24-48 hours. Nerve damage due to compression in the bone canal leads to oedema and secondary pressure, leading to ischemia and decreasing functions. Recovery varies from patient to patient but may last up to 1 year and is incomplete in 13% of patients (Walker, Mistry & Mazzoni, 2020).

According to the latest data from an article published in February 2022 on the Online Medical Education Platform (AMBOSS), the authors adhere to this version of the pathophysiology- fibers from both sides innervate the muscles responsible for eyelid and forehead movements:

- ✓ Central facial palsy- a unilateral upper motor neuron lesion between the cortex and nuclei in the pons (corticobulbar tract), but the eyelids and forehead muscles are still supplied by input from the other side, so the function is saved
- ✓ Peripheral facial palsy- a unilateral lower motor neuron lesion inters muscles and the nuclei, resulting in the paralysis of the forehead muscles and ipsilateral eyelid as no other input reaches those muscles.
- ✓ Just the lower facial muscles are innervated by fibers from the contralateral hemisphere (via the ipsilateral peripheral nerve. and ipsilateral nuclei) because they are paralyzed in central and peripheral facial palsy (Amboss.com, 2022).

The facial nerve bilaterally innervates the forehead and eyelid muscles, and as a result, central and peripheral lesions (red x) produce unique findings on physical examination. A central palsy (middle image) results in contralateral paralysis of lower facial muscles, whereas a peripheral palsy (right image) results from complete paralysis of the ipsilateral face, see pic.3 (Amboss.com, 2022).

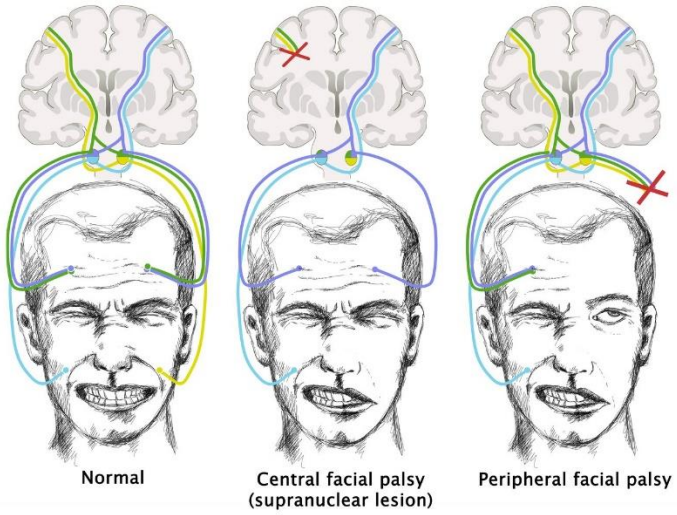


Figure 5. Examination findings in facial nerve palsy (Amboss.com, 2022).

1.2.2 Signs and symptoms

BP usually presents with sudden weakness of facial muscles on one side of the face. For the first time, the patient may notice this only by looking in the mirror or by the patient's family members Pain behind the ear, anomaly of taste present. And paresthesia on the ipsilateral cheek. Salivation from the corners of the mouth is the initial symptom. often noted (Heckmann et al., 2019). ***Bell's Palsy Acute onset of unilateral upper and lower facial paralysis over a 48-hr period.*** Decreased tearing. Posterior auricular pain. Otalgia. Hyperacusis. Taste disturbances. ***Early symptoms include***: poor eyelid closure. Weakness of the facial muscles. Alteration of taste, 57%. Ocular pain. Aching of the ear or mastoid, 60%. Tingling or numbness of the cheek/mouth. Hyperacusis 30%. Epiphora. Blurred vision. Bell's palsy usually appears suddenly early in the morning, but since it takes several hours for symptoms to appear, it can be assumed that it starts at night. ***Early ocular signs include***: brow droop, lagophthalmos (inability to close the eye completely), corneal exposure, paralytic ectropion of the lower lid, upper eyelid retraction, loss of

the nasolabial fold, corneal erosion, infection, and ulceration (rare), decreased tear output/poor tear distribution. ***Late ocular signs include:*** abnormal regeneration of the facial nerve with motor synkinesis, mild, generalized contracture of the facial muscles, making the affected palpebral fissure narrower than the opposite a few months after, contracture of the facial muscles together with twitching the corner of the mouth or pitting the chin at every blink can also be present, permanent, disfiguring facial paralysis (rare), autonomic Synkinesis (i.e., crocodile tears—tearing with chewing). Around two-thirds of patients complain about tear flow because the function of the orbicularis oculi, which is transporting the tears, is reduced. Fewer tears enter the lacrimal sac, and overflow occurs; the production of tears is not accelerated (Bell Palsy: Practice Essentials, Background, Anatomy, 2020).

Posterior auricular pain. Nearly 50% of the patients with Bell palsy complain about posterior auricular pain. The pain is often combined with the paresis, but pain precedes the paresis by 2–3 days in about 25% of patients. The patient should be asked about experienced trauma, which may account for the pain and facial paralysis (Bell Palsy: Practice Essentials, Background, Anatomy, 2020).

Taste disorders. According to research, 80% of patients show a reduced sense of taste and one-third report taste disorders. Patients may not notice what reduced taste is because the side of the tongue is uninvolved Early sense of taste returning mean that the patient will have a complete recovery (Bell Palsy: Practice Essentials, Background, Anatomy, 2020).

Facial spasm. An infrequent complication of Bell palsy is a facial spasm, which arises as a tonic contraction of 1 face side. Spasms are more likely to occur during stress or fatigue, occur during sleep, and more often occur in patients 50-60 years of age. This condition may result from compression of the seventh nerve root by an aberrant blood vessel, demyelination of the nerve root, or tumor. Sometimes it is difficult to identify the etiology. These may be brain stem lesions if progressive facial hemispasm is present with the involvement of other cranial nerves (Bell Palsy: Practice Essentials, Background, Anatomy, 2020).

Facial paralysis. Paralysis involves the forehead and lower part of the face. The patient cannot close his eyes, smile at the affected side and may also reveal increased salivation on the side of the paralysis. If the paralysis penetrates only the lower part of the face, then there is a suspicion of a central cause: a supranuclear one. It may be a stroke or an intracerebral lesion if the patient complains of contralateral weakness or diplopia and supranuclear facial palsy. Suppose the patient has a gradual onset of facial paralysis, trauma, weakness of the contralateral side, or a history of infection. In that case, it is essential to consider possible causes of facial paralysis.

Progression of paresis usually lasts no more than 7-10 days if already more suggestive of another diagnosis. Patients presenting with bilateral facial paralysis should be considered for Guillain-Barré syndrome, meningitis, and Lyme disease. In many patients, the side of the paralysis becomes numb, as it were. It may be secondary to the suspicion of a trigeminal nerve lesion. However, some research suggests that this symptom is likely due to a lack of facial muscle mobility rather than a lack of sensation (Bell Palsy: Practice Essentials, Background, Anatomy, 2020).

According to the latest data from an article published in February 2022 on the Online Medical Education Platform (AMBOSS), the authors adhere to this version of the signs and symptoms; check Table 1. And the further description:

Table1. Motor signs in central and peripheral facial palsy (Amboss.com, 2022).

Motor signs in central and peripheral facial palsy		
Clinical feature	Central (signs are contralateral to the lesion)	Peripheral (signs are ipsilateral to the lesion)
Ability to frown or lift eyebrows	• Intact	• Impaired
Ability to close the eyelids completely	• Intact	• Impaired
Mouth drooping	• Present	

- ✓ sensory disturbances: loss of sense of taste in the part of the tongue in front (anterior tongue part), painful sensation behind and around the ear hyperacusis
- ✓ Dry mouth (because of decreased saliva production)
- ✓ Ocular features. Lagophthalmos: inability to completely close the eye (due to paralysis of the orbicular oculi muscle). Decreased lacrimation. Ectropion. Corneal ulceration and keratitis. Bell's phenomenon: with an active attempt to close the eyelid, a physiological reflex movement of the eye occurs (out and up).
- ✓ Facial Synkinesis: involuntary, unwanted movements of the facial muscles (for example, when closing the eyes, facial spasms occur) (Amboss.com, 2022).

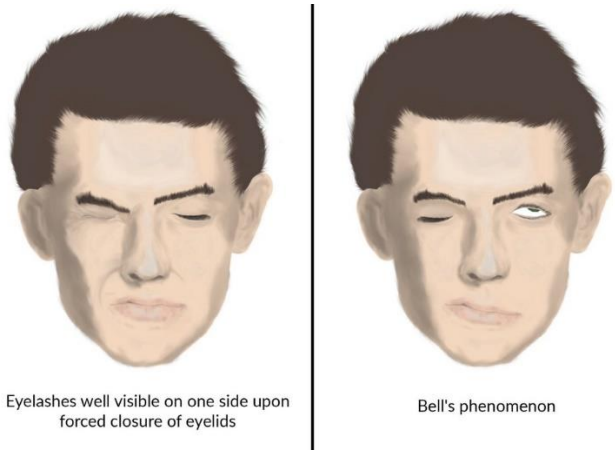


Figure 6 Bell's phenomenon (on the right image): the patient cannot completely and correctly close the affected eye. Reflex upward and outward movement on closing the eyes, showing white sclera (Amboss.com, 2022).

1.2.3 Classification and grading system

The grading system created by House and Brackmann categorizes Bell palsy:

- ✓ Grade I: normal facial function
- ✓ Grade II: mild dysfunction: slight weakness is noted, forehead motion is moderate to good, slight Synkinesis may be present, but normal symmetry and tone are noted at rest, slight mouth asymmetry
- ✓ Grade III: moderate dysfunction: the difference is noted between the face sides

  small Synkinesis, contracture or hemifacial spasm, forehead movement is slight to average, normal symmetry and tone are noted at rest, a slightly weak mouth, full eye closure is achieved with effort, full eye closure is achieved with minimal effort

- ✓ Grade IV: moderately severe dysfunction: weakness and disfiguring asymmetry, symmetry, and tone are typical at rest, eye closure is incomplete, no forehead motion is observed
- ✓ Grade V: severe dysfunction: only a barely perceptible motion, no forehead motion, asymmetry at rest, eye closure is not entirely, mouth movement is only slight
- ✓ Grade VI: total paralysis: gross asymmetry, no movement (Bell Palsy: Practice Essentials, Background, Anatomy, 2020).

In s Synkinesis, evaluation is mostly common: The Sunnybrook Facial Grading System and the electronic physician graded scale (eFACE). Sunnybrook Facial Grading System is a well-established grading system that includes five standard facial expressions to assess the movement and extent of Synkinesis. The SBGS scale was the most often used outcome measure in a recently held systematic review. The eFACE is an electronic scale consisting of smile and dynamic scores with a synkinesis score, which is anatomically separated and allows objective measurements to be obtained based on clinical photographs, which allows for both documentation of abnormal movements and evaluation of therapies employed (Shokri et al., 2021).

1.2.4 Clinical assessment

Examination for Bell palsy. Paralysis or weakness due to damage to the facial nerve extends to the entire face, upper and lower on the affected side. A detailed examination of the head, ears, nose and throat, and eyes is necessary. In addition, a mandatory examination of the skin for signs of squamous cell carcinoma, which can also affect the facial nerve, and a check for diseases of the parotid glands (Bell Palsy: Practice Essentials, Background, Anatomy, 2020). Most important in the initial evaluation of a patient with facial weakness is the difference between lower motor neuron palsy (LMN) and upper motor neuron palsy (UMN), treatment for these will differ significantly due to different etiologies. By applying the anatomy and medical history of the patient during the examination, it is possible to determine the actual cause of facial paralysis and subsequently prescribe the appropriate corrective treatment (Walker, Mistry & Mazzoni, 2020; Facial Nerve Paralysis: Overview, Anatomy, Pathophysiology, 2021).

Focus on voluntary movements of the upper part of the face on the affected side, since with supranuclear lesions, a stroke of the cerebral cortex in most cases, the upper third of the face is mobile, and the lower two-thirds are paralyzed. The explanation is that the circular, frontal, and corrugator muscles are innervated bilaterally at the brainstem level. When examining a patient, a flattening of the forehead and nasolabial folds on the side subject to paralysis is noticeable. When a patient tries to raise their eyebrows, the paralyzed side of the forehead remains flat. When he tries to smile, the face lateralizes in the opposite direction (Bell Palsy: Practice Essentials, Background, Anatomy, 2020).

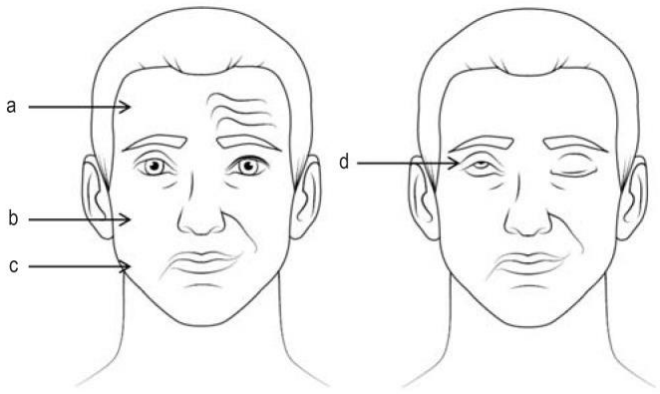


Figure 7 Signs of peripheral paralysis of the facial nerve, right-sided: a) decreased mobility of the forehead; b) usually smoothed nasolabial fold; c) visible lowered corner of the mouth; d) impaired eyelid closure with Bell's phenomenon (Heckmann et al., 2019).

- ✓ ***Otologic examination***: and tuning fork examination, particularly recommended if evidence of acute or chronic otitis media is present. The ontological examination consists of tuning fork examination and pneumatic otoscopy. An otologic cause should be taken into account if the patient's history or examination reveals signs of acute or chronic otitis media or a history of ear surgery. Suspicion of Ramsey-Hunt syndrome: herpes zoster should cause an accompanying rash, vesicles along the mouth and ear canal, auricle. Mandatory examination of the ear canal to exclude infections or injuries. The patient may feel tingling in the back of the auricle and decreased sensitivity. Hyperacusis is possible in a Patient with stapedial palsy. A stethoscope loudness test will help identify this (Bell Palsy: Practice Essentials, Background, Anatomy, 2020).
- ✓ ***Oral examination:*** Taste and salivation are often affected. It is also necessary to examine the oral cavity since many patients have impaired salivation and taste sensations. The test can be done by holding the tongue with gauze and testing each side of the tongue with salt, vinegar, or sugar. The mouth must be rinsed after each test. The affected side will have a reduced taste compared to the healthy side. Salivation can be checked like this: the doctor places a small catheter in the paralyzed and normal submandibular glands. The patient is asked to suck on a lemon, and the count of saliva flow between the two sides is compared (Bell Palsy: Practice Essentials, Background, Anatomy, 2020).
- ✓ ***Ocular examination:*** The patient is often unable to close their eye on the affected side completely. When paralysis of the orbicularis oculi muscle (facial nerve innervation) happens but left normal function of the levator muscle: oculomotor nerve innervation and Mueller's muscle: sympathetic innervation, the patient is often unable to close the eye fully on the affected side. When the patient tries eye close, the eye rolls upward and outward on the affected

side. This action is known as the Bell phenomenon. Moreover, the tear reflex is absent in many cases. On this basis, the patient may have corneal abrasion and dry eyes and loss of the corneal reflex affected by the paralysis side; but the contralateral eye blinks. The Schirmer blotting test can be used to assess tear function. The application of benzene will stimulate the nasolacrimal reflex, and the degree of lacrimation can be compared between the paralyzed and the healthy side (Bell Palsy: Practice Essentials, Background, Anatomy, 2020; Facial Nerve Paralysis: Overview, Anatomy, Pathophysiology, 2021).

- ✓ ***Neurologic examination:*** All cranial nerves, sensory and motor, and cerebellar testing are recommended. The neurological examination includes a complete examination of all cranial nerves, sensory and motor testing, and testing of the cerebellum. Detection of Neurological abnormalities requires a referral to a neurologist with further tests: MRI of the brain, lumbar puncture and EMG (Bell Palsy: Practice Essentials, Background, Anatomy, 2020).

The facial motor nucleus gets afferent information from several places and takes part in various reflexes: ***The corneal reflex*** can be tested by stimulating the cornea with a cotton swab, which will cause reflex closure of both eyelids. The facial nerve mediates the efferent part, and the afferent part of this reflex is the trigeminal nerve. ***The orbicularis oculi reflex*** can be elicited by supraorbital nerve stimulation with sound and light. The trigeminal, optic and vestibulocochlear nerves produce the afferent part of this reflex. The efferent branch is the facial nerve with the induction of bilateral blinking of the eyes. ***The orbicular oral reflex (nasal reflex)*** is manifested during percussion of the upper lip and leads to an ipsilateral rise in the angle of the mouth. The trigeminal nerve acts for the afferent part of the reflex, and the facial nerve for the efferent part (Dulak & Naqvi, 2020).

According to the latest data from an article published in February 2022 on the Online Medical Education Platform (AMBOSS), the authors adhere to this version of clinical assessment: Medical patient anamnesis, history. Ask about symptom onset and duration: is it acute, progressive. Check for possible causes, make assessments for stroke, recent infections, tumors, and when was last trips to nature, other countries. Physical examination checking for facial asymmetry at rest. Checking for facial asymmetry in movements. Measure the facial muscle strength. Spot the differences between motor signs in central and peripheral facial palsy. Perform a complete neurological examination: all things neurological signs considered. Check all the signs indicating a connection with shingles, erythema migrants, herpes zoster, tick bites face observation on signs of trauma (Amboss.com, 2022).

1.2.5 Differential diagnosis

The diagnosis of Bell's palsy should be based on a thorough history and physical examination, and diagnostic tests when appropriate. Bell's palsy diagnosis should be made with the method of exclusion. The features of the disorder that distinguish it from other causes of facial paralysis are the sudden onset of unilateral facial paralysis and, accordingly, the absence of signs and symptoms of involvement of the CNS, ear, and cerebellopontine angle. Patients with recurrent ipsilateral facial paralysis should undergo MRI or high-resolution computed tomography (CT) to rule out this cause of recurrence as neoplastic or inflammatory, e.g., multiple sclerosis, sarcoidosis. Failure to correctly recognize structural, vascular, or infectious lesions leading to the involvement of the seventh cranial nerve may lead to a worsening of the patient's condition in the future. Other neurological conditions such as stroke, basilar meningitis, Guillain-Barré syndrome, and cerebellopontine angle tumor should be considered if other cranial nerves are involved and motor or sensory symptoms are present. A seventh nerve's neoplasm symptoms include slowly progressive paralysis, severe pain, facial hyperkinesis, recurrent paralysis, and others. In the case of Tumors of the cerebellar pons, the seventh, eighth and fifth cranial nerves can be affected simultaneously. Patients with progressive facial paralysis should be examined if it has lasted for more than three weeks. With Recurrent ipsilateral facial paralysis, there is a suspicion of a tumor of the facial nerve or parotid gland, with the obligatory consideration of a tumor of the temporal bone: neuromas, meningiomas, hemangiomas, as well as malignant and metastatic lesions. If the patient comes from the northeastern United States, consider Lyme disease the cause of facial paralysis, 5-10% of patients with this disease have facial paralysis. Ramsey-Hunt syndrome is possible with the sudden onset of hearing loss and severe pain with the onset of facial paralysis. Usually, also in these patients, there is an erythematous vesicular rash affecting the ear canal, oropharynx, and auricle (Bell Palsy: Practice Essentials, Background, Anatomy, 2020; Facial Nerve Paralysis: Overview, Anatomy, Pathophysiology, 2021; Zhang et al., 2019; Shokri et al., 2021).

Other problems to be considered. Acute or chronic otitis media. Acoustic neuroma and other cerebellopontine angle lesions. Aneurysm of the vertebral artery, basilar or carotid arteries. Amyloidosis. Botulism. Geniculate ganglion infection. Autoimmune syndromes. Carotid disease and stroke. Congenital malformation. Facial nerve schwannoma. Guillain-Barré syndrome. Leukaemia/lymphoma. Leukemic meningitis. Carcinomatosis. Herpes zoster. Cholesteatoma of the middle ear. Meningitis. Nasopharyngeal carcinoma. Osteomyelitis of the skull base. Glomus tumors. Mycoplasma pneumonia. Otitis media Pontine lesions. Human immunodeficiency virus

(HIV) infection. Sarcoma. Skull base tumor. Parotid gland disease or tumor. Teratoma. Malignant otitis externa. Wegener granulomatosis. Viral syndromes. Tuberculosis (Bell Palsy: Practice Essentials, Background, Anatomy, 2020; Walker, Mistry & Mazzoni, 2020; Shokri et al., 2021).

Additional considerations based on history. Anesthesia nerve blocks. Diphtheria. Melkersson-Rosenthal syndrome. Alcoholic neuropathy. Barotrauma. Carbon monoxide exposure. Basal skull fractures. Birth trauma. Benign intracranial hypertension. Forceps delivery. Facial injuries. Kawasaki disease. Facial trauma (blunt, penetrating, iatrogenic) (Bell Palsy: Practice Essentials, Background, Anatomy, 2020; Walker, Mistry & Mazzoni, 2020).

Bilateral cases: it is rare, less than 1% of the frequency of unilateral facial paralysis and accounts for only 23% of cases. Typically, such patients have Guillain-Barré syndrome, sarcoidosis, meningitis, Lyme disease, or bilateral type 2 neurofibromas.

Differential Diagnoses: acute Complications of Sarcoidosis. Brainstem Gliomas. Brainstem Gliomas. Benign Skull Tumors. Tuberculous Meningitis. Intracranial Hemorrhage. Cerebral Aneurysms. Meningioma. Lyme Disease in Emergency Medicine. Neurosyphilis (Bell Palsy: Practice Essentials, Background, Anatomy, 2020).

1.2.6 Prognosis

The natural course of Bell's palsy ranges from early full recovery to significant nerve damage with irreversible consequences such as permanent paralysis and Synkinesis. According to the prognosis, ***patients are divided into three groups:*** group - complete restoration of facial motility (without effects), group - Incomplete restoration of the motor function of the face, but without visible aesthetic defects, group - persistent neurological consequences, manifested both outwardly aesthetically and clinically (Bell Palsy: Practice Essentials, Background, Anatomy, 2020; Shokri et al., 2021). On average, 80–90% of patients diagnosed with Bell's palsy recover without noticeable disfigurement within six to 3 months. The Sunnybrook scale to assess facial nerve function within one month predicts the likelihood of recovery. 70% of patients recover fully between six and nine months. Elderly patients recover less and more slowly than younger ones, and men are less well than women (Heckmann et al., 2019). Most patients with Bell's palsy have neuropraxia or local nerve block. They are likely to have a quick and complete recovery of the nerve. However, with axonal rupture, patients with axonotmesis recover pretty well, but usually not wholly (Bell Palsy: Practice Essentials, Background, Anatomy, 2020). With Idiopathic facial

paralysis, there is usually a complete recovery in about 85% of cases—the recovery period of three weeks. Improper growth of nerve fibers can lead to disorders such as Synkinesis (Amboss.com, 2022).

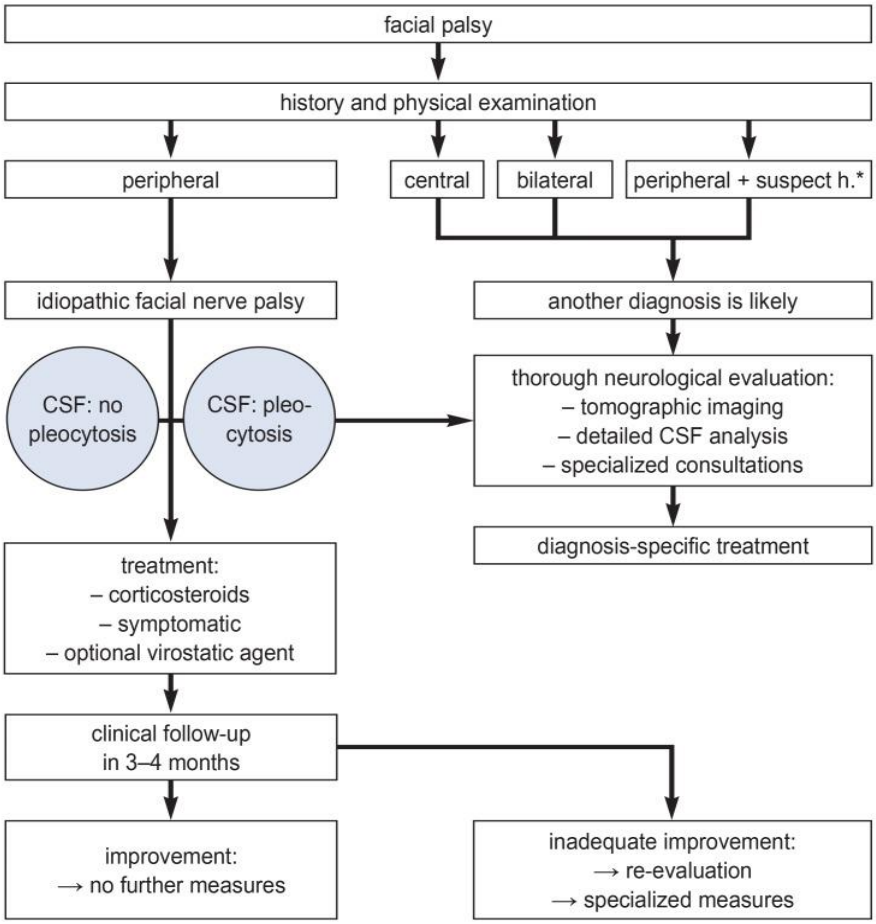


Figure 8 Care algorithm **(**Heckmann et al., 2019).

Risk factors associated with poor prognosis for patients with Bell's palsy: age over 60**,** complete paralysis and decreased taste sensation**,** decreased salivation on the paralyzed side (25% compared to the normal side)**,** pain in the back of the auricle and decreased lacrimation**.** The sooner the recovery comes, the less likely the consequences will develop. If the recovery already begins within three weeks, then we can say that the recovery is expected to be complete. If between 3 weeks and two months, the result is usually satisfactory. If recovery does not occur before 2-4 months from the onset of the disease, then most likely, the risk of irreversible consequences, including residual paresis and Synkinesis, has increased. Suppose there is no recovery within four months. In that case, the patient will most likely still have the consequences of the disease, such as Synkinesis, crocodile tears, and sometimes hemifacial spasm occurs. Bell's palsy recurs in 4–14% of patients and may recur on the same or opposite side of the original palsy. Relapse is usually

associated with a family history of recurrent Bell's palsy. (Bell Palsy: Practice Essentials, Background, Anatomy, 2020; HUANG, WANG & DING, 2021).

1.2.7 Consequences and complications

After suffering from Bell's palsy disease, up to 30% of patients have long-term symptoms, and 5% remain with consequences of high severity, including incomplete motor regeneration, incomplete sensory regeneration, and aberrant facial nerve reinnervation. ***Incomplete engine regeneration***. The most significant portion of the facial nerve is composed of efferent fibers that stimulate muscles of facial expression. Suboptimal regeneration of this portion results in paresis of all or some of these facial muscles and is shown as oral incompetence, epiphora (excessive tearing), and nasal obstruction. ***Sensory regeneration is not completed.*** Dysgeusia or ageusia: impairment, loss of taste, can occur when the drum string is not fully regenerated. Incomplete regeneration of other afferent branches can lead to dysesthesia: impaired sensitivity, unpleasant sensitivity to normal stimuli (Bell Palsy: Practice Essentials, Background, Anatomy, 2020).

Complications. Unrepairable damage to the facial nerve**.** A massive growth of nerve fibers that provokes involuntary contraction of some muscles when trying to move others (Synkinesis)**.** Partial or complete blindness of the non-working eye cannot be closed due to excessive dryness and scratches on the cornea. After an injury, the facial nerve grows back, but this process can occur chaotically and lead to spontaneous excitation, followed by involuntary contractions of the facial muscles. HFS can develop months or even years later (Bell Palsy: Practice Essentials, Background, Anatomy, 2020; Baylor College of Medicine, 2021).

1.2.8 General Management for Bell’s Palsy patients

Treatment goals: improve seventh cranial nerve function, reduce neuronal damage and prevent complications from corneal exposure. ***General treatment includes:*** antiviral agents, corticosteroid therapy (prednisone), eye care: Topical ocular lubrication is usually sufficient to prevent abrasions, corneal drying and ulcers. Local ophthalmic therapy is helpful in most cases. However, if the condition is already severe and prolonged, surgical treatment is better to protect the cornea. These procedures make it possible to reduce the use of lubricating drops and ointments, improve the cosmetic effect and are sometimes even necessary to preserve vision on the affected side. ***Surgical***

treatment option: facial nerve decompression, transposition of the temporalis muscle, facial nerve grafting, subocularis oculi fat lift, tarsorrhaphy, I implantable devices, placed into the eyelid, direct brow lift. ***Pharmacological therapy***: the most commonly used treatment for Bell's palsy is corticosteroid therapy. However, the use of steroids is still controversial, as most patients recover without treatment. Antiviral drugs and combinations of the two types of drugs are also contentious. Oral glucocorticoids: regardless of severity. Should be Start early as possible, best within 48–72 hours of symptom onset. Currently recommended prednisone or prednisolone. Antiviral and steroid therapy may need to be combined (should be not used as monotherapy). Currently recommended acyclovir OR valacyclovir. ***Surgical options for Bell palsy:*** Direct brow lift. Facial nerve grafting. Facial nerve decompression**.** Implantable devices (e.g., gold weights) are placed into the eyelid**.** Tarsorrhaphy. Subocularis oculi fat (SOOF) lift. Transposition of the temporalis muscle. ***Facial Nerve Decompression***; surgery to decompress the facial nerve is controversial. Patients with poor prognoses, identified by facial nerve testing or persistent paralysis, benefit most from surgical intervention. However, studies have been mixed regarding the benefit of surgery.

Non-drug measures are also used to treat Bell's palsy, namely ***physical therapy***. The most popular are facial exercises, neuromuscular retraining, and acupuncture. Research results suggest that physiotherapy generally leads to faster recovery and reduced sequelae (Bell Palsy: Practice Essentials, Background, Anatomy, 2020; Amboss.com, 2022; Walker, Mistry & Mazzoni, 2020). Exercise therapy is recognized as one of the most effective physical rehabilitation methods, namely, neuromuscular facial re-education (NMR). This method aims to normalize muscle tone and prevent the development of synkinesis. The patient has explained the anatomy of the muscles and the mechanisms of their work; unconscious movements are subjected to conscious control with the help of biofeedback - proprioceptive, sensory, and visual. For example, the simplest and most popular type of biofeedback is visual - a mirror, more complex - electroneuromyography. This type of treatment is long-term; it can take from 18 months to 3 years. In a review of several studies, Suzanne W. van Landingham et al. (2018) demonstrate only the positive effects of LUT with BFB, and the type of feedback does not matter (van Landingham, Diels and Lucarelli, 2018). One of the most effective and frequently used NMT methods is Kabat therapy (Kabat and Knott, 1953). Maurizio Barbara et al. (2003) conducted a retrospective study of the effectiveness of early application physical rehabilitation, according to Kabat system (neuromuscular facilitation) in patients with acute FN neuropathy after surgical treatment for acoustic neuroma VIII. Faster and better recovery of the function of mimic muscles was observed in patients who received early rehabilitation using the Kabat method: more than 60% of patients with grades IV-V recovered to II-III, while only 10% of patients without rehabilitation with grade IV, they reached II-III, and for

patients with grade V, a good result was practically unattainable (Barbara et al., 2003). Manikandan N. et al. (2007) conducted a randomized controlled trial that included patients with acute BP. The first group underwent NMR; the second received standard therapy following the clinic protocol (electrical stimulation, rough facial exercises, massage). Patients in the first group were asked to focus on the quality rather than the quantity of exercise performed. In order to avoid overwork, the subjects performed exercises 5-10 repetitions three times a day and tried to maintain the symmetry of the involved and non-involved sides, i.e., restrained the arbitrary movements of the party involved. The patients used a mirror as feedback. After three months of treatment, patients in the two groups improved symmetry, but more significant results were observed in the individual NMR group. However, it is not possible to speak about the significance of differences given the small sample and the duration of the disease (Manikandan, 2007). A systematic review of randomized and quasi-randomized controlled trials was done by Katie A Fargher & Susan E Coulson (2017). Five studies were included for analysis: four during acute convalescence and one during chronic facial paralysis. In acute facial paralysis, two studies found no benefit from electrical stimulation, and two studies found improvement. A meta-analysis of changes in the House-Brackman scale after treatment rates, complete recovery rates, and time to complete recovery did not significantly differ between the experimental and control groups (Fargher & Coulson, 2017). Monini S. et al. (2016) also proved the effectiveness of exercise therapy in treating BP in a prospective study. Patients with acute BP showed a pronounced decrease in the strength of facial muscles within seven days from the onset of the first symptoms. Twenty-eight patients underwent early NMR (Kabat method); 66 patients did not. In the Kabat therapy group, patients were initially more severe. Kabat patients were about 20 times more likely to improve by three degrees of HB or more (OR = 17.73, 95% CI = 5.72–54.98, $p < 0.001$) than patients who did not receive this physical therapy and the average the BP recovery rate in this group was half that in the group (subjects from Kabat). Unfortunately, there were no differences in the frequency of synkinesis between the two groups. (Monini et al., 2016). Exercise therapy with the performance of movements with maximum amplitude is called "rough exercises." For example, smile as much as possible. This treatment method is controversial because it can lead to the aggravation of pathological patterns. In addition, cases of development of synkinesis after treatment with the use of "rough exercises" have been described (van Landingham, Diels and Lucarelli, 2018). Controversial treatments also include electrical stimulation of the muscles on the ipsilateral side of neuropathy to prevent muscle atrophy. The main cause of immobility may not be lethargy but an increase in muscle tone and contraction of the antagonist's muscles. According to a meta-analysis from 2017, the use of electrical muscle stimulation in the acute period is not justified and

not justified; the method can only be applied during the chronic period. In addition, cases of the development of synkinesis have already been described after the use of electrical stimulation. The latest work by Suzanne W. van Landingham et al. (2018) cites a personal communication from therapists who noted more pronounced synkinesis in patients who had previously received electrical muscle stimulation. The method continues to be studied since it is still unclear what prevails - the benefit of the method or the risk of complications (van Landingham, Diels and Lucarelli, 2018; 61]. According to a systematic review of four studies, electrical stimulation was not recommended. Patients without clinical improvement or worsening in the form of progressive muscle weakness should be referred to a specialist in the treatment of LN to decide on the appointment of exercise therapy (de Almeida et al., 2014). Taping limited the development of asymmetry of the nasolabial folds and the development of synkinesis; however, in all studies, the method was used in conjunction with other treatment methods, so it is not clear which contributed more to the positive effect of therapy. The study by Kasahara T. et al. (2017) demonstrated the effectiveness of taping in developing oro-ocular synkinesis. However, the tape was applied to the face in a non-traditional way, around the mouth, and the sample of patients was tiny (van Landingham, Diels and Lucarelli, 2018; Kasahara et al., 2017). Patients with FN neuropathy and synkinesis often develop high muscle tone over time, which can lead to pain and reduce the available range of motion. Hypertonicity is traditionally observed in the area of the nasolabial folds and bands of the subcutaneous muscle of the neck. The best way to reduce muscle tone, soft tissue mobilization, heat, massage, or a combination of both can be used. Low-frequency laser therapy has been proposed as an additional treatment for FN neuropathy in combination with exercise therapy, but there is no scientific explanation for this recommendation. In all studies, laser therapy was prescribed only in conjunction with other methods. Therefore, it has no evidence base (van Landingham, Diels and Lucarelli, 2018).

Many patients with Bell's palsy have problems with drinking and eating, swallowing food and impaired speech due to muscle weakness and associated facial asymmetry; occupational therapy and speech therapy are highly recommended. Treatment will help improve speech clarity and reduce the risks associated with dysphagia, which will minimize social embarrassment or self-awareness (Bell Palsy: Practice Essentials, Background, Anatomy, 2020).

Recommendations for physiotherapists. Like additionally, it can be recommendation do not to forget what a crucial methodological principle is to equate the strength and amplitude of contraction of the muscles of the healthy side to the still limited capabilities of the muscles of the affected side. This essential rule must be observed in all types of facial muscle training at different

stages of treatment. During the stretching and the contraction phase of the PNF stretch, it is unnecessary to apply maximum force or intensity. PNF stretching works best when a gentle bit and contraction are used. It is always important to properly instruct the patient about home exercises that he will perform independently. It is better to give fewer exercises so that the patient clearly remembers how to perform them and does not harm himself.

Recommendations for patients. To prevent corneal abrasions, the patients can be instructed about eye care. Verry recommended doing facial muscle exercises using a passive range of motion and actively closing their eyes and smiling. Facial exercises help Bell palsy patients increase facial muscle strength and coordination. These exercises include raising the eyebrows and holding them in the raised position for 10–15 seconds, snarling and curling the lips, tilting the head, wrinkling the nose and stretching the neck. All these exercises can be performed patient by himself at home after classes with a physiotherapist (Bell Palsy: Practice Essentials, Background, Anatomy, /2020). If the eye is not entirely closed, eye care should be started (e.g., eye ointment and bandage or an eye patch, artificial tears). In case of incomplete mouth closure, it is recommended to properly care for the lips and mouth (Amboss.com, 2022).

1.3 Synkinesis

Abnormal, involuntary facial movements accompanied by voluntary facial movements are called Synkinesis. In patients with persistent facial paralysis, the frequency of Synkinesis reaches up to 55%. Unfortunately, researchers have not yet come to a complete understanding of this severe, debilitating condition leading to reduced quality of life and functional limitations (Shokri et al., 2021).

1.3.1 Mechanism

Researchers have recently proposed several possible mechanisms of facial Synkinesis, including ephaptic transmission, aberrant regeneration, various changes in the cerebral cortex, and facial nucleus hyperactivity in the pons.

Aberrant regeneration. This Aberrant Regeneration Hypothesis was one of the first and most accepted explanations for the nature of Synkinesis. It is generally accepted that when the endoneurium and axons lose their integrity when the nerve is damaged, they can no longer properly regulate the growth of regenerative nerve fibers. Regenerative fibers move into neighboring

endoneurial tubes, where they develop and innervate the wrong muscles. An example that proves this theory is Baker's demonstrative, classic experiment on Javanese macaques. They suffered from post-paralysis ocular-oral synkinesis. For the experiment Using retrograde neuroanatomical indicators, it was found that the perioral muscles of the monkeys are innervated by nerve fibers, whereas initially, these fibers dominated the muscles surrounding the eyes. Many animal experiments support this theory of incorrect innervation during the regeneration of the facial nerves (HUANG, WANG and DING, 2021). Currently, the leading theory is that aberrant regeneration of nerves happens due to low myelination and reorganization of neural networks during re-growth and leads to "crosstalk" between distal nerve fibers, plus hypersensitivity facial nucleus, which causes involuntary activation of mimic muscles when attempting planned movements. After primary damage to the facial nerve, aberrant regeneration among nerve fibers can develop as early as three or four months up to 2 years (Shokri et al., 2021). Aberrant reinnervation of the facial nerve: during the regeneration and repair of the facial nerve, some nerve fibers may take an unusual direction and connect with neighboring muscle fibers. This aberrant reunion leads to distinctive neurological pathways. When voluntary movements begin, they are accompanied by involuntary movements like closing the eyes associated with pursing the lips or a grimace of the mouth that occurs during blinking of the eyes. This condition is called Synkinesis. Bell’s Palsy is an idiopathic, acute lower motor neuron palsy. Usually, the condition is unilateral and self-limiting inflammatory. Generally, BP continues within 4–6 months and almost always resolves entirely within less than one year. However, among those cases where the problem has not been resolved, many studies provide evidence that relapses of ischemia and the consequences are repeated, maybe even a third time or more. Eventually, it can lead to a thickening of the sheath of the facial nerve and the formation of the fibrous streak, causing compression of the nerve, thereby making recovery more difficult (Zhang et al., 2019; Bell Palsy: Practice Essentials, Background, Anatomy, 2020).

Ephaptic transmission. There was a hypothesis about abnormal nerve impulses arising between neighboring axons with incomplete myelin sheath formation; on this basis, the Theory of Ephaptic Transmission was developed. Between the axons that dominate different parts of the facial muscles, some shunts conduct a nerve impulse to another fiber, which, when excited, causes synchronous muscle movements. During the Hemifacial Spasm Study (HFS), it was found that shunts more often occur in the zone of entry of roots that are not protected by a myelin sheath. However, even after that, it is unclear whether this also works in post-paralytic facial Synkinesis. Takeda's research has shown that ephaptic transmission occurs during Synkinesis during HFS and is less related to prolonged Synkinesis after facial paralysis. From these studies of ephaptic

transmission, it can be concluded that post-paralytic Synkinesis and HPS have two different pathological processes (HUANG, WANG and DING, 2021).

Hyperactivity of the facial nucleus. Based on aberrant regeneration, the frequency of various patterns of facial Synkinesis after paralysis should be about the same since the distribution of the facial nerves is diffuse. However, Moran's experiment showed data that contradicted this. With the involvement of the zygomatic muscle leading to oral-ocular Synkinesis, the theory of aberrant regeneration is not working, as this muscle is involved in Synkinesis more often than another muscle. The result indicates that the process of regeneration of the facial nerve is selective, which attracted the attention of researchers to the involvement of the facial nucleus in post-paralytic facial Synkinesis. Correlated studies have shown excitability of the facial nuclei in patients with facial Synkinesis in a recent study by Suming et al. noticed that two specific types of motor neurons of the facial nucleus are involved in this pathological process (HUANG, WANG and DING, 2021).

Changes in the cerebral cortex. With the help of new examination technologies, namely functional magnetic resonance imaging (MRI) of the nervous system, it became possible to study the mechanisms of post-paralysis synthesis focused on changes in the cerebral cortex. During recovery after damage to the facial nerve, various functional transformations occur in the cerebral cortex. Changes and their severity can already be seen at an early stage of facial paralysis. Areas of the cerebral cortex, such as areas of processing, sensorimotor communication, and performance of regulation movements, show varying degrees of functional changes in cases of facial paralysis. In the study by Wang et al., there were tasks on smiling and blinking in both a group of healthy people and patients with post-paralytic facial Synkinesis. At the same time, MRI tested the activation of the cerebral cortex. As a result, it was seen that blinking and smiling in the contralateral primary sensorimotor cortex of the patients practically overlapped, while in the healthy group, the representations seemed to be separated from each other. Also, more intense activity was shown on the unaffected side than on the affected side. According to Wu et al., several brain areas in patients with Synkinesis differed from healthy people in the increased amplitude of low-frequency oscillations of the ipsilateral insula. It contributes to motor movements of the hands and eyes during motor control (HUANG, WANG and DING, 2021).

1.3.2 Management for synkinesis

Botulinum toxin type A (BT-A) injection is a classic treatment for post-paralytic facial Synkinesis. Clinical trials have proven the effectiveness of BTX-A injections in improving facial

symmetry and reducing involuntary facial movements. Recently, details about BTX-A injection therapy, differences between injection regimens, and their response to treating people with different patterns and backgrounds of Synkinesis have also been explored (HUANG, WANG & DING, 2021). Most physicians consider botulinum toxin injections is the optimal treatment. At relatively low doses of This protein, injected directly into the affected muscles. Will relax the affected muscles and prevent spasms without causing paralysis. Within three to four days, the improvement will be visible and can last until six months. Repeat injections are required at different intervals, depending on the individual's response. The procedure is plenty safe; side effects include facial weakness, an eyelid droop or increased tearing, all of which resolve over time (Baylor College of Medicine, 2021)

Surgical strategies for post-paralytic Synkinesis of the face mainly aim to modify the facial nerves and muscles. Surgical treatment plays a huge role in the treatment of facial Synkinesis, and the risks of surgery, particularly trauma to unused parts of the face and other problems, cannot be ignored (HUANG, WANG &DING, 2021).

Physiotherapy has an integral part in the treatment of synkinesis, with the primary goal being to maximize volitional control contraction of the facial muscles because of the execution specific exercises. It has been proven that these techniques improve zonal areas of hypokinesis with a decrease or further preventing the progression of Synkinesis at the same time (Shokri et al., 2021).

Neuromuscular re-education is one of the most important treatment options for facial paralysis. It is selective muscle control training for the progression of the quality of muscle movement. The stages of relearning restore the path of movement control from the peripheral to the central nervous system from the inside. Physiotherapy exercises therapy aims to develop electro muscular feedback, biofeedback, and other methods. This type of treatment is best for recovering from a complete nerve injury. During such therapy, using EMG, a mirror, or other instruments, patients gradually begin to control the occurrence of involuntary movements; this generates visual feedback from the cerebral cortex. Since mirror therapy and EMG are non-invasive treatments, it has recently become a hot research topic. The therapeutic value of these methods has already been confirmed in stroke rehabilitation, the treatment of phantom limb pain, etc. The fundamentals of mirror therapy include the theory of mirror neurons in the cerebral cortex—also a theory about the relationship between motor efferent commands and visual afferent signals. Paolucci et al. used software in their study that reproduces a duplicate of a patient's non-paretic face on a computer screen, an image of the patient's entire face before the face distortion. This type of rehabilitation training improves the facial function of patients; this type of

rehabilitation encourages patients by showing them their healthy faces. The effectiveness of neuromuscular re-education proves that the cerebral cortex is associated with the development of post-paralytic facial Synkinesis. Based on the hypothesis of improving brain plasticity, direct stimulation, such as repeated transcranial magnetic stimulation, may bring a more immediate and direct therapeutic effect. The severity and duration of symptoms, age, gender, etc., influence the design of a particular treatment. A combination of several therapies will lead to better recovery outcomes. A combination of mirror therapy, BTX-A injection, surgery followed by BTX-A injection, or other treatments has proven far superior to monotherapy (HUANG, WANG & DING, 2021; Zhang et al., 2019). Physiotherapy contains various simultaneous methods, including biofeedback, neuromuscular retraining, soft tissue massage, mobilization, and meditation. Electrical stimulation, Electromyographic feedback and mime therapy also have great results in this patient population (Shokri et al., 2021). A study by Lindsay et al. showed that targeted rehabilitation therapy of the face significantly improved facial function scores in 303 patients by facial assessment over a five-year trial. Patients passed facial rehabilitation, including neuromuscular training, massage, meditation-relaxation and home programs tailored to each individual (Shokri et al., 2021). Based on recent research, the most effective methods for treating Synkinesis were recognized Botulinum toxin type A (BT-A) injections, surgical intervention and neuromuscular retraining (physiotherapy) (HUANG, WANG& DING, 2021). Chemo denervation with botulinum toxin and neurorehabilitation is still considered the primary strategy for treating facial Synkinesis, but new methods are already being developed, such as selective neurolysis techniques, selective myectomy, etc. and nerve transplants. Rehabilitation includes soft tissue massage, neuromuscular retraining and relaxation therapy, and botulinum toxin therapy in intractable cases of Synkinesis and flaccid facial paralysis to applied surgical interventions such as nerve transplantation or free muscle transfer, selective neurectomy and selective myectomy (Shokri et al., 2021).

2. EMPIRICAL PART

2.1 Research methodology

A systematic review of the most recent literature was conducted, following the PRISMA flowchart, to gain a broader and faster understanding of the impact of manual physical therapy techniques and an active physical therapy approach on the treatment and prevention of synkinesis in adult patients with Bell's palsy. The review includes scientific articles on the study and analysis of various methods of manual physiotherapy and an active physiotherapeutic approach to the treatment and prevention of synkinesis in adult patients with Bell's palsy. Qualitative analyzes of the studies were performed, evaluating treatment and outcomes. The review aimed to investigate and assess manual physical therapy techniques and an active physical therapy approach in treating and preventing synkinesis in adult patients with Bell's palsy.

2.1.1 Information sources

The search was performed the following three electronic databases:

- ✓ PubMed
- ✓ MEDLINE (accessed from EBSCO host service)
- ✓ Google Scholar

The research was done from 10 April 2022 to 30 April 2022. The search included studies in English, completed and published in the last five years to have an updated overview of the most efficient manual physiotherapy technique and active physiotherapy approach. The studies involved only adult patients. The following words or combinations were used to search for articles in the databases: physiotherapy, rehabilitation, facial, Bell’s palsy, synkinesis.

The search line was as follows: ((synkinesis) AND ((facial) OR (Bell’s)) AND ((palsy) OR (paralysis)) AND ((management) OR (treatment) OR (rehabilitation))

2.1.2 Study selection

To select eligible articles, inclusion and exclusion criteria were chosen. Intended criteria for ***inclusion of scientific articles:***

- ✓ The articles were published in English language
- ✓ The articles were published in the last 5 years
- ✓ The articles evaluate the effect of manual physiotherapy technique for preventing and/or treating Synkinesis in adult patients with Bell’s Palsy
- ✓ The articles evaluate the effect of active physiotherapy approach for preventing and/or treating Synkinesis in adult patients with Bell’s Palsy
- ✓ Research articles and full texts
- ✓ Free access to the publications

Exclusion criteria for scientific articles:

- ✓ The articles were published in a language other than English
- ✓ The articles have been published more than the last 5 years
- ✓ The articles do not describe the effect of manual physiotherapy technique or active physiotherapy approach for preventing and/or treating Synkinesis in adult patients with Bell’s Palsy
- ✓ Facial paralysis of central origin, bilateral facial paralysis, pediatrics (age <15 years), adults in ages > 60 and articles dealing with animal experiments. These criteria were chosen because too many articles matched the search equation. The pediatric population was excluded so as not to introduce a growth bias. The exclusion of surgical, antiviral, steroid and other drug treatments are justified by their too high a number. Their too high number justifies the exclusion of articles reviewing treatments such as Botox injection therapy. They risk contributing bias to our review of the literature and seem irrelevant.
- ✓ There is no clear intervention
- ✓ There are no clear results

Recent exceptions such as surgical interventions, pharmacology, and Botox were also considered, but only if they were combined with physiotherapy rehabilitation methods.

All articles of the systematic review were included that met the inclusion criteria set out in the table (Tabl. 4).

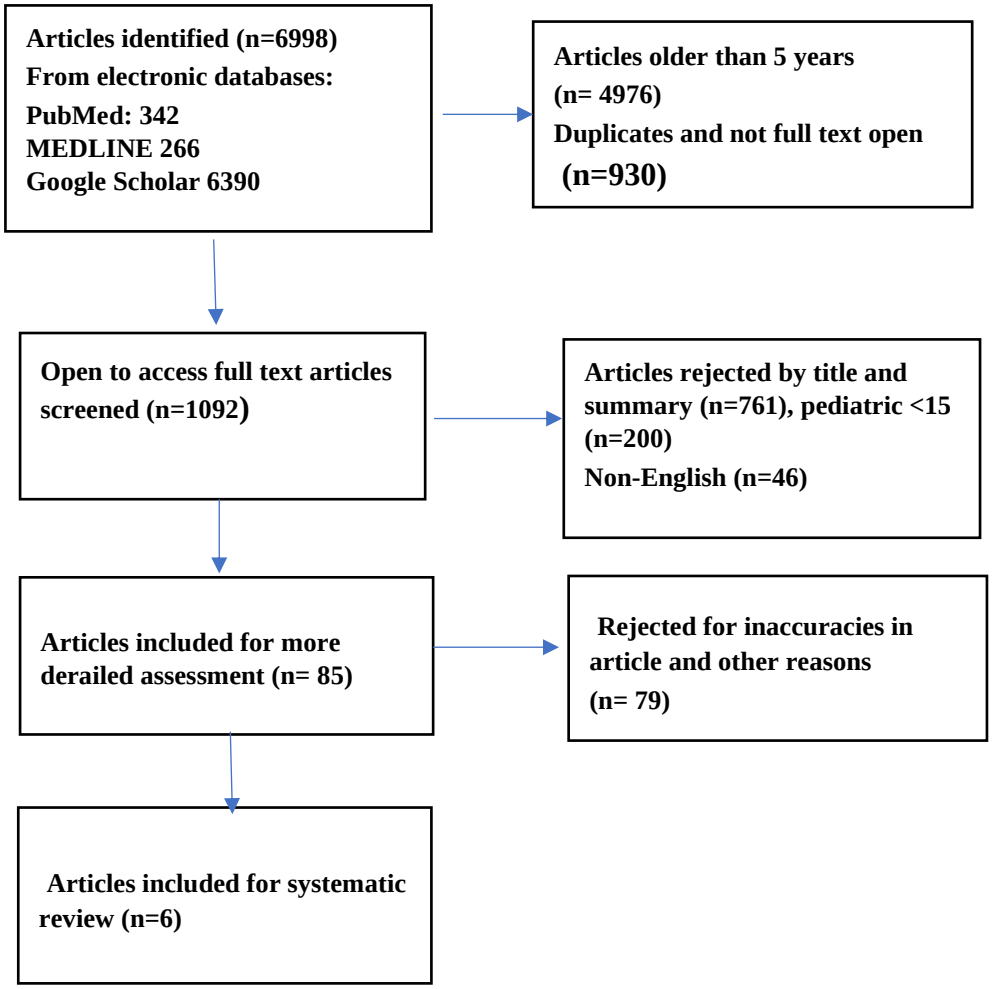
Table 4. Inclusion and exclusion criteria

Criteria	Inclusion criteria	Exclusion criteria
Language	English	Other foreign language
Deformation	PNP, Bell’s Palsy, Sunkunesis	Other deformations
Type of the article	Scientific articles and complete texts	Scientific reviews, meta-analyses, completion of graduation work.
Age	15 - 60 years old participants	Under 15 years, over 60 years
Article publishing Year	2017 - 2022	Older than 2017 Articles
Publication availability	Freely available articles from home	Article access restricted from Home
Methodology	Manual therapy. Active approach	Other methodologies

2.1.3 Research selection process

The search strategy applied is as follows: the first sort is performed first, according to the inclusion criteria, namely date and article type. Only randomized controlled clinical trials are included. The second sorting is done after reading the article's title, and the third sorting is done immediately after reading the abstract. The final sorting occurs after reading the entire article. It is then included in the overall review, depending on whether it meets the inclusion criteria and whether there is a practical assessment of the potential effect. When searching for scientific sources, 6998 articles were found; after research selection, 6 articles were considered according to inclusion and exclusion criteria. In scientific research, the selection scheme is shown in Table. 5. Out of 6998 articles, 4976 older than five years were rejected, 930 duplicates and inaccessible in full-text open access were removed, and 761 articles were rejected by title and summary, 200 removed as participants were <15 years and, articles in non-English 46 and 79 articles were rejected due to inaccuracies and other reasons.

Table 5. PRISMA flowchart diagram.



2.1.4 Data analysis

Five articles were analyzed: 5 randomized controlled trials (RCTs). All included studies examined the results obtained by various methods with the direct participation of the physiotherapy team who administered the treatment, educated patients on at-home rehabilitation and evaluated the effects together with other members of the rehabilitation team. All included in the study participants had PNP the studies ranged in size from 20 to 64 patients. The total number of participants was 169: male and female, and the mean age in the studies ranged from 15 to 60 years. The duration of follow-up ranged from 4 weeks to 12 months. The study design, sample size, type of treatment analyzed/compared, duration, baseline, and study results are presented in Tabl.6 below, which summarizes the aspects considered and the overall results of the art.

Table 6. Summary of results

Author, year	Study design	Sample size, sex, age	Duration	Intervention	Improvement		Results
					PFP	S-s	
Khan, 2020	Randomized controlled trial (RCT) The study was undertaken at 3 hospitals in Faisalabad, Pakistan	30 patients with *Group A* (n=15) *Group B* (n=15) mean age 35 years, with 14 males and 16 Bell’s palsy	3 times per week 4 weeks (30 min.).	Group A: Conventional therapy (electrical muscle stimulation and facial exercise) Group B: ***mirror therapy*** in which after application of EMS, the exercises were performed in front of a mirror	+	+	Mirror therapy group A showed significant improvement in resting symmetry score, the symmetry of voluntary movement, and synkinesis score at the end of treatment sessions which shows mirror therapy in addition with conventional therapy is a helpful and an effective treatment for Bell’s palsy.
MORISHIMA et al., 2020	Randomized controlled trial (RCT) The study was undertaken at 5 hospitals in Japan	A total of 51 patients, adults. were enrolled, 39 with a diagnosis of Bell’s palsy and 12 with a diagnosis of Ramsay Hunt syndrome.	Both protocols (30 min.) + (30min.) at home. Duration 2 months	MS ***group: Muscle straightening program*** Small movements of muscles close to the midline. (SMCI) in order to strengthen individual muscles. Non-MSG group: Eye-opening exercises to prevent oral-ocular synkinesis. Both group: Ordinary treatment Prohibition of maximum effort movements and electrical stimulation. Stretching of the affected facial muscles when muscle tone appeared. Mirror biofeedback therapy to reduce the synkinesis movement when synkinesis appeared.	+	_	Voluntary Movement Score was significantly higher in the MS group than in the Non-MS Group. The Resting Symmetry Score was significantly lower in the MS Group, whereas the Synkinesis Score showed no significant effect muscle strengthening on PFP difference between both groups. These results suggested that the strengthening of individual muscles may help to improve paralysis without effect on synkinesis
Siva Sankar & Gopikrishna, 2021	Randomized controlled trial (RCT)	30 patients with *Group A* (n=15) *Group B* (n=15) both men &women, 20-70 years, with diagnosis of Bell’s Palsy	4 weeks, six days per week. (30 min.)	*Group A:* conventional therapy: gross facial expression exercises, thermo therapy and massage. Group *B:* ***NMR,*** individual techniques, performing symmetrical movements of the face on the affected side, both groups used a hand-held mirror during the exercise program. following these exercises at home as well for three months	+	+	Both the groups Neuromuscular re-education and Conventional therapy has shown improvement in reducing facial disability in subjects with Bell's palsy. However, Neuromuscular reeducation showed statistically significant when compared to Conventional therapy in reducing facial disability.

Goyal & Koley, 2021	Randomized controlled trial (RCT) College of Punjab, India.	20 patients (both male and female) with diagnosis of Bell's palsy, age group 20-70 years *Group A* (n=10) *Group B* (n=10)	4 weeks, galvanic stimulation with 3 sets and 30 contractions in each set.	*In Group-A*, patients were treated with Proprioceptive ***Neuromuscular Facilitation*** (PNF) and Neuromuscular Re-Education (NRE) along with interrupted galvanic stimulation, facial massage and home-based exercises. In *Group-B*, patients received the treatment of interrupted galvanic stimulation and manual facial massage along with home based facial exercises program in front of mirror. For both groups: manual facial massage facial exercises program in front of mirror at home.	+	+	The treatment protocol comprised of PNF and NRE along with interrupted galvanic stimulation, facial massage and home-based exercises was more effective than only interrupted galvanic stimulation, facial massage and home-based exercises in improving facial symmetry and reducing facial disability in patients with Bell's palsy.
Pourmomeny et al., 2021	Randomized controlled trial (RCT) Physiotherapy clinics, Isfahan, Iran,	15 females, 11 males (mean ages from 37 to 44) with diagnosis of PFP, and synkinesis on the affected side. *Experimental (BTX-A) (n=13)* and *control (NMRT) (n=13) group.*	From 8 to 12 weeks. 1 session of BTX, and three 45-min sessions each week, exercises with mirror as home *(NMRT) group.*	Group (BTX-A) *The diluted toxin was then infused into the synkinesis muscular tissues at three to seven sites. The* (***NMRT)*** group *got the massaging the soft tissue, stretching the contracted muscles of the affected side, relaxing the tense muscles, and giving EMG for muscle strengthening and synkinesis control.*	+	+	synkinesis was successfully managed and resolved in both groups, but in the *MNRT group* increased significantly.
Hussain, 2021	Randomized controlled trial (RCT) Mujahid Hospital, Madina Town, Faisalabad.	64 participants (15-60 years), mean weight 85-114 kg, diagnosis Bell's Palsy Group 1 (n=32) Group 2 (n=32) 19males, 48 females	7 weeks Consecutive sessions 3 weeks 4 weeks at home	*group 1* received ***mirror visual feedback*** and neuromuscular reeducation and patients in *group 2* received ***neuromuscular reeducation only***.	+	+	Mirror Visual Feedback and Neuromuscular Retraining and Neuromuscular Retraining alone in improving the degree of severity and disability scores. statistically significant improvement was demonstrated in reducing recovery time of the patients. NMR with MVF is found more effective in enhancing the symmetry and movement of face and in decreasing the functional disability

2.2 RESULTS

Our literature review aims to determine, based on the five included clinical trials, that physiotherapy affects the treatment of synkinesis in PNP. These included studies have identified some rehabilitation methods, the effectiveness of which we will discuss after reviewing the results. We will then discuss the biases inherent in our trials, and finally, we will attempt to offer a consensus that is useful for clinical practice. Most systematic reviews came up with results showing that physiotherapy was promising. However, its effect was unclear because the quality of the evidence was limited, and the sample size was small.

Mirror therapy

Currently, there are already many studies whose results confirm the effectiveness of mirror therapy in patients with Bell’s Palsy. Some studies found similar results as the current study, done by Khan, 2020. Where twenty-two patients were randomized into two groups: 11 to a mirror therapy group and 11 to the traditional rehabilitation group myofascial-approach and mime-therapy Results showed significant improvements in the mirror therapy group when comparing results was done. Thereby, the effectiveness of mirror therapy in peripheral facial palsy patients is supported (Paolucci et al., 2020). A similar study done by Barth et al., 2020 reviewed the charts of 25 patients with idiopathic FP. 10 of the participants received facial physical therapy, including postural exercises and manual therapy. Fifteen of these participants received mirror book therapy and standard facial physiotherapy treatments. Moreover, after done conclusion, mirror book therapy, in plus to standard facial physiotherapy treatments, does significantly improve outcomes in the treatment of idiopathic facial palsy. Significantly improve the results in the rehabilitation of people who have an idiopathic facial paralysis (Barth et al., 2020). Used the resources of Pub. Med was found in an excellent article review by Pourmomeny & Asadi, 2014, where the database was used from 1980 to mid-2013. Since no open access articles have been found on synkinesis treatment over the past five years, consider this meta-analysis. This review included one hundred twenty-four clinical articles about synkinesis and FNP treatments. Studies included in the review used physiotherapy rehabilitation treatment, an electromyogram (EMG) and mirror biofeedback. The total number of patients enrolled in all these trials was 269. All included studies applied a comparative analysis between different methods. Biofeedback was compared with methods such as mime therapy, neuromuscular exercises and neuromuscular education. All involved studies had indications that it is effective in terms of facial symmetry and emphasized the value of EMG biofeedback. Some studies found good improvement in symmetry and reduction of synkinesis.

And some studies found that EMG biofeedback was more effective than mirror biofeedback (Pourmomeny & Asadi, 2014).

In the study carried out by Khan, 2020, 15 participants underwent conventional therapy (EMS and Facial Exercises). The other 15 participants underwent ***mirror therapy*** in which after, exercises were given in front of the mirror. This paired sample t-test shows a significant result in the post-treatment session with p-value=0.00. It shows that both treatments (conventional and mirror therapy) showed improvement within the groups. However, compared to conventional therapy, mirror therapy was an effective treatment with a mean value of 70.67 ± 11.127. The mirror therapy group showed noticeable improvement in resting symmetry score (7.13±3.441), the symmetry of voluntary movement (79.53±13.282), and synkinesis score (2.40±1.957) at the end of treatment sessions, which shows that mirror therapy in addition with conventional therapy is a helpful and effective treatment for Bell’s palsy. It is concluded that mirror therapy is an effective treatment for improving facial symmetry, facial movements, and decreasing synkinesis in patients with Bell’s palsy (Khan, 2020).

Hussain's study, 2021, also considered the effect of mirror therapy on treating Bell's Palsy in adults and preventing and treating their consequences. In this trial, the sample consisted of 62 participants, patients having idiopathic one-sided Bell's palsy, divided into two groups, 32 in each, in the age range between 15-and 60. Participants in group 1 received ***visual mirror feedback*** and neuromuscular reeducation, patients in the second group received neuromuscular reeducation only. The study was done in seven weeks. The questionnaire was filled, firstly at the baseline, then after the third week, and the final then assessment was done t after the seventh week. First 3 weeks, the patient was under physiotherapist control, and after, the patient was guided to do home exercises at home. The assessment was done using the Facial Disability Index (FDI) and House Brackman Scale (HBS). The patient had practiced this in front of a mirror twice a day with about five repetitions. All scores from FDI-PF = Facial Disability Index-Physical Function; FDI-SF = Facial Disability Index-Social Function; SAQ = Synkinesis Assessment Questionnaire; SFGS = Sunnybrook Facial Grading System in the first group was much higher. In the results, Facial Disability Index at baseline 30.0781+5.45267 in the first group (with mirror therapy and after seventh weeks it 109.3125 +1.84806. In group 2(only NMR) at baseline FDI =30.0469+5.93358 and after seventh weeks =88.0000 +10.91093. HBS at Baseline 4.97+.177 (+mirror therapy group), 5.00+0.00 (only NMR). HBS at the seventh week in the first group 1.06+.246, in the second 1.91+0.588. A significant difference was observed in FDI-P, FDI-S and HBS scores at seventh week follow up between 2 groups. Visual Feedback and Neuromuscular Retraining and

Neuromuscular Retraining alone improve the degree of severity and disability scores in Bell's palsy patients.

Muscle strengthening exercises

In systematic review, which was conducted by Lim, 2021 to investigate the effects of facial exercise on facial muscle strengthening. In this review, most of the positive results from straightening facial exercises around the mouth on orofacial function: labial closure strength, tongue elevation strength, orbicularis oris endurance, and the sealed lip ratio were confirmed (Lim, 2021). A study done by Palekar et al. compared the Proprioceptive Neuromuscular Facilitation (PNF) method to Kinesio Taping with facial exercises program in participants with Bell's Palsy. Thirty people aged 20-40 participated and were divided into groups A and B. Group A got physical therapy with the PNF method, which included two sets with 15 repetitions in maximum resistance. Group B fulfilled facial exercises with Kinesio Tape. Both groups had the complementary treatment five times per week, with a session duration of 30 minutes. Duration 4 weeks the results showed that group B had a more significant improvement in facial muscle function than group A (Palekar et al., 2019)

In the study carried out by MORISHIMA et al., 2020. The first group, the MS Group underwent the ***muscle strengthening intervention.*** Initially, the muscles were strengthened through tiny movements of muscles close to the midline: the orbicularis oculi, orbicularis oris and corrugator supercilia; after, when improvement of the facial muscles was shown, muscle contraction exercises (SMCI) were connected to strengthen individual muscles. The participants were studied to contract their facial muscles only on the affected side and not contract any other muscles, focus on the strengthening of the orbicularis oculi, frontalis muscle, zygomaticus major and minor, corrugator muscle, and risorius individually while hold the healthy side by hand the participants. *In* the Non-MS Group meantime, eye-opening executive exercises to prevent oral-ocular synkinesis. These participants were instructed to keep their forehead still during the eye-opening exercise and continuously perform the exercise. The subjects in both groups also received, among other things, other treatments, such as the prohibition of maximum effort movements and electrical stimulation and mirror biofeedback therapy to reduce the synkinesis movement when synkinesis appeared. The patient protocol took 30 minutes to finish, and all participants were encouraged to perform them for a minimum30 of minutes a day at home. All three of these interventions were commenced within two months from the onset of PFP. The outcomes were measured by the Sunnybrook Facial Grading System (FGS): (Resting Symmetry Score), voluntary facial movements (Voluntary Movement Score), and synkinesis (Synkinesis Score) six months

after onset (primary endpoint) and twelfth months after beginning (secondary endpoint). However, *strengthening exercise* does not appear to improve synkinesis, but compared to rough exercises, controlled muscle strengthening exercises that focus on individual muscles may well be helpful in improving voluntary movement without worsening synkinesis in patients with Bell's palsy (MORISHIMA et al., 2020).

Neuromuscular re-education

In a reviewed study conducted by Siva Sankar & Gopikrishna, 2021 patients in the first control group received conventional treatment and patients in the second group received facial ***neuromuscular re-education*** techniques, which were chosen individually and conventional therapy. The conventional treatment included gross facial expression exercises, massage, and thermotherapy in the first group. The complex exercises consisted of kneading, pressing, tapping and stroking by fingers, from 5 to 10 repetitions of 3 to 5 exercises to be done two times per day. Also included were facial expressions and exercises for the eyes, in particular closing, frowning, raising the eyebrows, smiling, jaw and mouth movements, wincing and pouting, growling, chewing gum on the paralyzed side, inflating a balloon, using a straw, and pronouncing vowels. In the second group, patients were treated with neuromuscular retraining techniques. In order to avoid fatigue, patients were instructed to do only 5-10 repetitions of facial exercises at first, three once a day. Also, facial movements on the affected side had to be symmetrical, not allowing arbitrary movement uninvolved side, with movement distortion. Isolated movements were mined without mass action or synkinesis. Facial massage projections were on several areas, including lower facial muscles: mouth exercises, forehead, upper face and cheeks massage while using fingertips to perform circular motions. During the massage, bandages were applied to the skin of the face to maintain the face's symmetry. The main emphasis was placed on the quality of the exercises. But their quantity. It was also recommended to use a hand mirror during the exercise program for visual feedback. Exercise at home for three months was recommended with the provision of a daily journal. In results of the study showed a statistically significant change between pre-and post-treatment scores of the Facial Disability Index in both groups. Still, in the second group, scores after treatment were much higher. Neuromuscular re-education used in the second group is a problem-solving approach to treatment using selective motor training to facilitate symmetrical movement and control undesired gross motor activity. However, Neuromuscular re-education showed statistically significant improvement in Bell's Palsy patients compared to conventional therapy (Siva Sankar & Gopikrishna, 2021).

Another study was done by Goyal & Koley, 2021, considered the effect of neuromuscular re-education on adults with Bell’s palsy and synkinesis. However, there is a comparison between the two groups. The first group was treated with ***Proprioceptive Neuromuscular Facilitation (PNF)*** and ***Neuromuscular Re-Education (NRE)*** and interrupted galvanic stimulation, facial massage and home-based exercises. In the second group, patients received the treatment of interrupted galvanic stimulation, manual facial massage, and a home-based facial exercises program in front of the mirror. The PNF techniques used in managing facial paralysis conditions included rhythmic initiation, repeated stretch (repeated contractions), isotonic and percussion of tendons or margin and fascia of the muscle. PNF technique was given to all the facial muscles one by one, and the irradiation technique was utilized to facilitate the contraction of weaker muscles. NFR The PNF techniques used in managing facial paralysis conditions included rhythmic initiation, repeated stretch (repeated contractions), a combination of isotonic and percussion of tendons or margin and fascia of the muscle creating abnormal patterns of movement (synkinesis). They interrupted galvanic stimulation with a rectangular waveform with 100 ms, 3 sets and 30 contractions in each set. Manual facial massage includes effleurage, finger to thumb kneading, wringing, hacking, tapping and stroking. Home-based facial exercises in front of a mirror will be taught for four weeks. The patient will be reassessed after four weeks. Exercises included: widen the eyes and then frown, flare nose and relax, fill the air in mouth and release. Repeat, hold the straw in mouth – suck and blow out air. Show as if blowing a balloon, close tightly eyes, and then wide open, smile, grin, say ‘O’ and try to whistle, pronounce the vowels or their combinations aaeeou. From the findings of the study, it could be concluded that the treatment protocol comprised of proprioceptive neuromuscular facilitation and neuromuscular re-education along with interrupted galvanic stimulation with a rectangular waveform with 100 ms, three sets, and 30 contractions in each set, facial massage and home-based exercises was more effective than only interrupted galvanic stimulation with rectangular waveform with 100 ms, three sets, and 30 contractions in each set, facial massage and home-based exercises in improving facial symmetry and reducing facial disability in patients with Bell's palsy (Goyal & Koley, 2021).

In one of the most recent new studies, exciting results regarding synkinesis in an adult with unilateral peripheral facial paralysis have been deduced. The research was done by Pourmomeny et al., 2022, which compared the effect on synkinesis between the two groups, where Botox (BTX-A) was used for this in one group and ***retraining (NMRT)*** in another. This research has been the first study that directly compared two such different treatments in patients with synkinesis. The diluted toxin was then inserted into the synkinesis muscular tissues at three to seven sites. Botox

was injected into the synkinesis muscles around the eye and the synkinesis muscles around the mouth. NMRT treatment included massaging the soft tissue, stretching the contracted muscles of the affected side, relaxing the tense muscles, and giving EMGBFB for muscle strengthening and synkinesis control. This treatment lasted the 4-months: three 45-min sessions were performed each week, and the home training was prescribed mirror biofeedback. As a result, the BTX-A group, in the sum of FGS scores, were 45.14±18.2 and 48.36±17.5 (before and after the treatment). For comparison, the FGS composite score of the NMRT group increased from a mean of39.83±16.2 to 64.17±10.4 ($P<0.01$) (after treatment). The synkinesis in both groups significantly improved, but in NMRT group results are more revealing (Pourmomeny et al., 2022).

From the results of the 6 studies, we studied in the present literature, physiotherapy interventions (manual techniques and active approach) appear as a factor that can improve the symptoms of patients with BP and some improvement for synkinesis. We concluded that Mirror Therapy is a practical approach to improving facial symmetry when applied for four weeks, three times per week (30 min. sessions), and contributes significantly to improving facial functioning (Khan, 2020). The positive effect of the exercises with protocols (30 min.) + (30min.) at home for two months is supported by the research of MORISHIMA et al., 2020, which results suggest that the strengthening of individual muscles may help improve paralysis without effect on synkinesis (MORISHIMA et al., 2020). Our review has shown that Neuromuscular re-education has been statistically significant in reducing facial disability. Results were obtained from a study done by Siva Sankar & Gopikrishna, 2021, where the technique was used for four weeks, six days per week (30 min. sessions) (Siva Sankar & Gopikrishna). Our results showed that the treatment protocol comprised PNF and NRE, which were used on patients for four weeks to improve facial symmetry and reduce facial disability in patients with Bell’s palsy (Goyal & Koley, 2021). Encouraged and pleased with the results recorded in one of the rare studies so far, where the experimental group of patients received Neuromuscular Re-Education treatment, and as opposed to patients who received Botox, they had better results in improving synkinesis. The re-education treatment lasted 12 weeks, with three 45-min sessions each week and exercising with a mirror at home (Pourmomeny et al., 2021). Moreover, the previous study we reviewed proved that the effect is still better when the techniques are combined, as it was in this study, done by Hussain, 2021. So, the results of using the two techniques together: Mirror Visual Feedback and Neuromuscular Re-education, have outperformed those of neuromuscular retraining alone (Hussain, 2021).

2.3 DISCUSSION

From the active physiotherapy Approach discussed above, we have mirror therapy (biofeedback therapy) and exercise therapy. This interventional research, done by Mirzakhani et al., 2017, included 20 patients with acute unilateral peripheral facial palsy, divided into two groups. First group: ***Exercise therapy*** included receiving massage, making patterns of Proprioceptive Neuromuscular Facilitation (PNF) and second group: some exercises in front of a mirror; besides, ***biofeedback therapy*** contained massage and muscular education by biofeedback set. Exercise’s therapy lasted 22-minute, including 2 minutes of slow stroking massage with oil and 20 minutes strengthening program to reduce elevating eyebrows, corner of the lip, closing eye, scowling and pursing lips were implemented (5 minutes for each of them). The Biofeedback therapy group received a 22-minute treatment, which included 2 minutes of massage. It was educated on making neck extensor or flexor patterns associated with face movements of Proprioceptive Neuromuscular Facilitation (PNF) and 13 exercises in front of the mirror for 20 minutes (5 times each). Results: After one month of doing two different programs in exercise and biofeedback groups, the apparent result in improvement in the Function of the face was noticed in each group. This study indicated that concerning ***both biofeedback and exercise therapies as treatment is effective.*** Increasing awareness of patients and training early movements have an essential role in improving improvement (Mirzakhani et al., 2017).

Study what was done by Tharani at all., 2017. in India, they were published in the International Journal of Current Advanced Research, compared the effect of ***PNF and conventional facial exercises***. Twenty participants who met the inclusion criteria were randomized into two groups. Group A received PNF and electrical stimulation, and group B received conventional exercises and electrical stimulation for six weeks. (5 days per week, 45 minutes for session). Sunnybrook facial grading and facial disability index were administered to find facial symmetry and facial function, respectively. Both group A and group B had shown improvements in facial muscle physical function and facial symmetry. Nevertheless, better improvements were seen in facial symmetry and facial muscle physical function in group A, who received PNF. It was influential in sharpening the mouth. So, it can be recommended that PNF be used as an adjective for electrical stimulation in improving facial symmetry and facial muscle function in persons with Bell’s palsy (*Comparision of Pnf versus Conventional Exercises for Facial Symmetry and Facial Function in Bell’s Palsy | International Journal of Current Advanced Research*, 2018).

In 2020 Vaughan et al. did a systematic review of physical rehabilitation for facial palsy based on results from studies reporting the effectiveness of ***active physical therapy***. Where were included studies: one RCT by Kang J.A., 2017, one RCT by Huffman A.L. 1978, and two case series by Hagg M., 2008 and by Hee-Su P et al. l., 2018. All four studies reported high scores in improving the condition of Bell's Palsy. Kang JA et al., 2017 reported improvements in measures (facial movement coefficients) and HBGS in the control and experimental groups (both groups performed the ***physical exercise*** treatment). With the experimental group receiving ***mirror therapy, feedback*** as an experimental condition. Huffman AL.1978, also reported an improvement three times higher for subjects receiving EMG feedback versus mirror feedback. Both cases of the series implemented lip ***muscle strengthening*** protocols with the help of tools with exercise. Hee-Su P et al., 2017 reported an improvement in the strength of the circular muscles of the mouth and the function of closing the lips during swallowing no results specific to facial palsy (e.g., scores movement or symmetry). Hagg et al., 2008, also reported improvements in baseline ***lip strength*** (Vaughan et al., 2020).

It is difficult to say precisely which technique will be more effective for treating Bell's Palsy and its consequences. Until now, the nature of this disease has not been fully elucidated. The question of the origin of synkinesis remains open as well. One thing is clear for sure synkinesis is the consequence of the Bell's Palsy, which means treating the disease itself; we prevent the appearance of synkinesis. From work done above, it can be concluded that some techniques are good in treating the disease but have no effect on improving synkinesis. Some techniques work well in the initial stage. Other techniques work well in the chronic stage.

At the end of the work, I would like to give a concept and a short explanation for each of the techniques and methods considered in this work. ***Proprioceptive Neuromuscular Facilitation*** is a more advanced form of flexibility training that involves stretching and contracting the target muscle group. PNF stretching is one of the more effective stretching methods for improving flexibility and increasing range of motion; also great for targeting specific muscle groups, increasing flexibility, and increasing muscle strength. There are many different ways of the PNF stretching principle. They are sometimes referred to as a light stretch, contract-relax (CR) stretch, or hold-relax stretch. Post-Isometric Relaxation (PIR) and Muscle Energy Technique (MET) are other variations of the PNF technique. Moreover, the relaxation-antagonist-contract (CRAC) contract is another option. (*The Stretching InstituteTM and StretchCoach.com*, n.d.). ***Facial neuromuscular re-education*** facilitates the return of intended facial movement patterns and eliminates unwanted facial movement and expression patterns. It is a process of

relearning facial movement using specific and accurate feedback. Basic Exercises of Neuromuscular Re-Education: Eye Brow Raise (Frontalis), Eye Closure (Orbicularis Oculi, Relaxation of Levator Palpebrae Superioris), Frowning (Corrugator Supercilii, Procerus), Snarl (Nasalis, Levator Labii Superioris), Lip Pucker (Incisivii Labii Superioris & Inferiouis), Pout (Orbicularis Oris Superiores, Mentalis & Depressors), Smile (Zygomaticus Major Levator Anguli Oris) (Bright & Victor, n.d.).

Researchers significantly focused on Physiotherapy: manual techniques and an active approach to solving the problem of synkinesis in Bell's Palsy adults. For example, neuromuscular reeducation in different ways with different methods and instruments comprised EMG biofeedback, mime therapy, a combination of massage and neuromuscular reeducation), mirror biofeedback, active, active-assistive, and resistive exercise programs. As can see from previously reviewed studies, neuromuscular reeducation was the most effective treatment. Agreeing with this technique comes from the anatomy, that the facial muscles do not have internal sensory receptors producing proprioception, and facial muscles do no closure with facial shields. Accordingly, they are small and dirigible with minimal contractions, where there is a significant risk for contracture and change in the movement pattern. Because exercise therapy should be done carefully over neuroplasticity, hence proved that visual and auditory biofeedback are suitable for neuromuscular reeducation and facilitate movement. For this reason, biofeedback instruments, especially are suitable. Theoretically, biofeedback is the regulation of exact, correct and wrong movements during expression or facial muscle activity. As a rule, movements of facial muscles in FNP have two ways: first-muscle should move but can’t for several reasons, and the second muscle should not move but moves involuntarily, as synkinesis. Biofeedback communicates with the patient about the quality of movement by correcting movement patterns. It is an instrument for neuromuscular reeducation. The patients hear or see muscle activity patterns and decide to change or strengthen them. The sensitivity of the EMG biofeedback instrument is set according to the power of a facial muscle to strengthen or eradicate muscle activity. In cases where treatment aims to produce symmetry on both sides of the face (for reducing and preventing synkinesis), several canals of EMG biofeedback are used simultaneously. Biofeedback therapy is a neuroplasticity way for patients with peripheral facial nerve palsy. Strengthening physiotherapy exercises is the off-treatment choice. However, if these exercises are applied in an ungrammatical and chaotic way or replace neuromuscular retraining, it creates a massive movement. Incomplete recovery from PFNP does not have to be only due to muscle weakness. If so, then this weakness is in the secondary stage. The facial muscles have few intrinsic sensory receptors; unlike other skeletal muscles, the

facial muscles are tiny and delicate, with minimal contractions, and there is a big chance of contractures and behavioral changes. Uncontrolled synkinesis causes tension and changes in facial expressions in a dynamic and static posture; based on these data, the main pathological problem with synkinesis concerns untimely muscle charges. Facial asymmetry occurs not only due to muscle weakness but also due to improper coordination between the two sides of the face. The result is massive movement and wrong coordination between muscles. Therefore, muscle coordination and synchronization should be the main components of treatment. For this reason, some researchers propose biofeedback therapy to control and reduce synkinesis and facial symmetry. Neuromuscular retraining takes precedence over exercise therapy. It can reflect normal or abnormal muscle movements and allows the patient to imagine hidden physiological events that are invisible to him, of which he is unaware.

Strengthening physiotherapy exercises is the one-off treatment choice. However, if these exercises are applied in an ungrammatical and chaotic way or replace neuromuscular retraining, it creates a massive movement. Incomplete recovery from PFNP does not have to be only due to muscle weakness. If so, then this weakness is in the secondary stage. The facial muscles have few intrinsic sensory receptors; unlike other skeletal muscles, the facial muscles are tiny and delicate, with minimal contractions, and there is a big chance of contractures and behavioral changes. Uncontrolled synkinesis causes tension and changes in facial expressions in a dynamic and static posture; based on these data, the main pathological problem with synkinesis concerns untimely muscle charges. Facial asymmetry occurs not only due to muscle weakness but also due to improper coordination between the two sides of the face. The result is massive movement and wrong coordination between muscles. Therefore, muscle coordination and synchronization should be the main components of treatment. For this reason, as already described above, some researchers propose biofeedback therapy to control and reduce synkinesis and facial symmetry. Neuromuscular retraining takes precedence over exercise therapy. It can reflect normal or abnormal muscle movements and allows the patient to imagine hidden physiological events that are invisible to him, of which he is unaware.

CONCLUSION

1. After systematic literature analysis it has been noticed that Bell's palsy is the most common cause among idiopathic unilateral facial palsy cases. Current statistics showed approximately 60–75%. More common in adults, pregnant women, and people with diabetes. (See Epidemiology.) Bell's palsy is an acute, unilateral, peripheral palsy of the lower motor neurons of the facial nerve. Usually resolves within time in 80-90% of cases. The cause of Bell's palsy remains unknown, although the disorder is polyneuritis with possible inflammatory, viral, ischemic, and autoimmune etiologies. Most of the available data indicate the herpes simplex virus and herpes zoster virus reactivation. High prevalence of novel coronavirus disease (COVID-19) and associated severe acute respiratory illness Coronavirus syndrome 2 (SARS-CoV-2) has led to the increasing number of cases of Bell's Palsy. Some reported cases of facial palsy were with the evidence presented associated with vaccine trials as well. (See Etiology.) Synkinesis is the sequel of paralysis, abnormal, looks like the involuntary facial movements accompanied by voluntary facial movements. At present still very difficult to treat, and there is still a debate about the proper treatment. (See synkinesis.)

2. After studying the scientific research, it can be concluded that, at present, the most effective way to prevent and treat synkinesis in Bell's Palsy adults can be considered one methodic, which has many names NMR, NRE: NeuroMuscular Retraining, NeuroMuscular re-education, NeuroMuscular Reprogramming. This method can be represented with different techniques, such as mirror, PNF Proprioceptive Neuromuscular Facility, and even techniques such as massage and classic facial exercises if carried out according to the principle of feedback. The therapist wants to force the patient to do the work of restoring function by self-activity from the inside out. Consequently, rehabilitation focuses on exercise programs to strengthen the unused neuromuscular pathways. Unfortunately, the most worn paths have developed sensory-motor amnesia; they cannot feel or respond to messages from the motor control centre. When exercise is performed, those pathways are not accessible. Techniques such as mirror therapy, Proprioceptive Neuromuscular Facility and other feedback techniques can be defined as manual techniques, can be by active physiotherapy approach, depending on the ways of applying. Muscle-strengthening exercises are a place to be, but only in the second stages of Bell's Palsy. When synkinesis appears, the application of this type of exercise has not to effect or can make it worse. However, still, one must understand that all these methods should be combined with drug therapy, possibly surgical intervention, for a better result.

RECOMMENDATION

Patient-specific rehabilitation program should be developed for each patient attending the healthcare facility to enhance the recovery process. The rehabilitation team should include a medical doctor, nurse, physiotherapist, psychologist and speech therapist. Clients should be educated regarding the preventive measures regarding the risk of facial palsy in the winter season. Clients should be must learn to take control of their disease and prevent the development of complications. All health professionals should be given all the necessary skills to employ a holistic approach to managing patients with facial palsy. Staff must update their knowledge through the course in seminars and training workshops. To increase the level of health education programs at primary and secondary health care facilities to prevent or reduce the incidence of facial palsy among populations. Campaigns (educational talks and workshops) should be offered at the facilities and community to make people aware of the disease and its management.

Further research on synkinesis pathophysiology is urgently needed to seek more efficient and noninvasive treatments. Clinicians should consider individual differences during the design of treatment plans. A good variety of assessments and communication with patients are always required.

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APPENDIX

Table A. The house and Brackmann scale for the severity of peripheral facial nerve palsy (Heckmann et al., 2019)

Grade	Description	Finding at rest	Forehead innervation	Lid closure	Mouth innervation
I	normal	normal	normal	normal	Normal
II	mild dysfunction	normal	reduced	nearly normal	nearly normal
III	moderate dysfunction	normal	still barely possible	still barely possible	Reduced
IV	moderately severe dysfunction	normal	none	incomplete	Asymmetrical
V	severe dysfunction	asymmetrical	none	incomplete	Asymmetrical
VI	total paralysis	complete loss of tone	none	none	None

Table B. Cranial nerve types and functions (Amboss.com, 2022).

Cranial nerve		Nerve type	Function
I	**Olfactory nerve**	Sensory	Smell
II	**Optic nerve**	Sensory	Vision The afferent limb of the pupillary light reflex
III	**Oculomotor Nerve**	Motor (somatic)	Eyelid opening (indirect): levator palpebrae superioris muscle Eye movement Superior rectus muscle: elevation, intorsion, and adduction
		Motor (parasympathetic)	Pupillary constriction Pupillary sphincter (Edinger-Westphal nucleus and muscarinic receptors) Efferent limb of the pupillary light reflex Accommodation: ciliary muscle
IV	**Trochlear nerve**	Motor	Eye movement: superior oblique muscle (intorsion, depression, and abduction)

V	**Trigeminal nerve**	Ssensory	Facial sensation: ophthalmic (CN V1), maxillary (CN V2), mandibular nerve (CN V3) Innervation of: Mucous membranes of the oral and nasal cavity and the soft and hard palate Teeth Temporomandibular joint Meninges The anterior wall of the external auditory canal Somatosensation of anterior ⅔ of the tongue The afferent limb of the corneal and lacrimation reflexes (nasociliary branch) The afferent limb of the jaw jerk reflex (muscle spindle from masseter)
		Motor (only mandibular nerve)	Muscles of mastication Masseter, temporalis, medial pterygoid muscles close the jaw Lateral pterygoid muscles open the jaw Efferent limb of the jaw jerk reflex (masseter) Innervation of: Tensor tympani muscle (contraction dampens loud sounds) Tensor veli palatini muscle Anterior belly of the digastric muscle Mylohyoid muscle
VI	**Abducens nerve**	Motor	Eye movement: lateral rectus muscle: abduction
VII	**Facial nerve**	Sensory	Taste: anterior ⅔ of the tongue (chorda tympani) Innervation of: Tympanic membrane (chorda tympani) The skin behind the ear (posterior auricular branch)
		Motor (somatic)	Facial expression Eyelid closing: orbicularis oculi muscle Efferent limb of the corneal reflex (temporal branch, bilaterally) Jaw opening: the posterior belly of the digastric muscle Hyoid elevation: stylohyoid muscle Efferent limb of the acoustic reflex (stapedius muscle) → auditory volume modulation
		Motor (parasympathetic)	Salivation: submandibular and sublingual glands Lacrimation: lacrimal gland Efferent limb of the lacrimation reflex
VIII	**Vestibulocochlear nerve**	Sensory	Balance and equilibrium: vestibular nerve Hearing: cochlear nerve
IX	**Glossopharyngeal nerve**	Sensory	Taste perception: posterior ⅓ of the tongue (lingual branch) Somatosensation: posterior ⅓ of the tongue, middle ear, and Eustachian tube (tympanic nerve) The afferent limb of the gag reflex Visceral sensation: carotid sinus (baroreceptors for blood pressure) Chemoreception: carotid body (chemoreceptors for PaO2, PaCO2, and pH)