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editorial

Dear Readers,

The journal “Zdravotníctvo a sociálna práca” (Health and Social Work) was renamed in 2021 to International Journal of Health, New Technologies and Social Work.

Our long-term effort is to gradually acquire for the journal European significance and be included in international databases. Starting with issue No. 4 in 2016, the journal accepted the Harvard style of referencing, and changed guidelines for the authors. The aim of the changes was to move closer to the standard in international journals published in English in the area of health and helping professions. The editors are aspiring for registration in other relevant international databases. Since last 2020 the journal has published all articles in English only.

The journal “Zdravotníctvo a sociálna práca” (Health and Social Work) was established in 2006 at Faculty of Health and Social Work blessed to P. P. Gojdič in Prešov and St. Elizabeth University College of Health and Social Work in Bratislava. In 2021, the journal celebrated its 16th year of publication.

Previously professional journal, within 5 years developed into an international, peer-reviewed scholarly journal, published quarterly (4 issues per year). The journal were published by the St. Elizabeth University of Health and Social Work in Bratislava. The journal became international in 2009. The journal was published and distributed in the Slovak Republic and also in the Czech republic.

Since 2011, the journal is published both in print and as electronic issues, available from: www.zdravotnictvoasocialnapraca.sk. Starting by issue No. 3 in 2014, the scope of the journal has broaden and the journal is covering health sciences, such as Public Health, Nursing, Laboratory Medicine, but also helping professions such as Social Work or Pedagogy. Collaboration with Faculty of Health and Social Work of Trnava University in Trnava was initiated.

The journal is indexed in the following databases: Central and Eastern European Online Library — CEEOL (since 2018), Bibliographia Medica Slovaca (BMS), and Slovak reference database CiBaMed.

The part of journal is Supplementum, to publish abstracts from international conferences organized by the St. Elizabeth University of Health and Social Work in Bratislava. In 2022, the conference will take place in October in Piešťany, in the Slovak Republic.

Prof. Miron Šrámka, MD, DSc.
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Postcovid syndrome, nervous and sensory system

Postcovidový syndróm, nervový a senzorický systém

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ABSTRACT

Introduction: The aim of this study was to investigate the effect of post-COVID syndrome on the nervous and sensory system. The disorders occur in the central nervous system (CNS) and the peripheral nervous system (PNS). There are neurological, sensory, musculoskeletal, and neuropsychiatric disorders after COVID-19. The aim was to review recent publications and to determine the correlation between the disorders after overcoming COVID-19 and the dynamics and persistence of structural brain changes on MRI.

Materials and Methods: We present a review and analysis of the impact of COVID-19 on the nervous and sensory system. COVID-19 induces long-lasting neurological, sensory, musculoskeletal, and neuropsychiatric disorders. MRI brain scans show structural changes that result in neurological, sensory, and neuropsychiatric disturbances after COVID-19. The disturbances persist for months or years after COVID-19.

Results: Neurological symptoms with structural changes (MRI) of the brain continue to persist eight months after infection and may cause severe psychiatric disturbances. GBS can confirm PNS and exclude a disorder in the CNS.

Conclusion: A proportion of patients after SARS-CoV-1 and MERS infection do not return to a normal quality of life and experience neurological and psychiatric complications years after acute infection after overcoming COVID-19. They may have neurological, sensory, musculoskeletal, or neuropsychiatric disorders. Age over 65 years, chronic lung disease, cardiovascular disease, hypertension, diabetes, and obesity are risk factors for complications related to SARS-CoV-2 infection. After COVID-19, a brain MRI scan causes structural changes that result in neurological, sensory, musculoskeletal, and neuropsychiatric disorders that last for a long time.

Keywords: Post-COVID syndrome, nervous and sensory system, musculoskeletal and neuropsychiatric disorders, structural changes MRI brain.

ABSTRAKT

Úvod: Zistiť vplyv postcovidového syndrómu na nervový a senzorický systém. Poruchy sa vyskytujú v centrálnom nervovom systéme (CNS) i periférnom nervovom systéme (PNS). Po prekonaní COVID-19 sa objavujú/pretrvávajú neurologické, senzorické, muskuloskeletálne a neuropsychiatrické poruchy.

Cieľ: Cieľom bolo preskúmať najnovšie publikácie a určiť koreláciu medzi poruchami po prekonaní COVID-19 a dynamikou a pretrvávaním štrukturálnych zmien mozgu na MRI.

Materiály a metódy: Predstavujeme prehľad a analýzu vplyvu COVIDu-19 na nervový a senzorický systém. COVID-19 vyvoláva dlhodobé neurologické, senzorické, muskuloskeletálne a neuropsychiatrické poruchy. Pri MRI vyšetrení mozgu vznikajú štrukturálne zmeny, ktoré majú za následok neurologické, senzorické a neuropsychické poruchy po prekonaní COVID-19. Po prekonaní COVID-19 pretrvávajú tieto poruchy mesiace až roky.

Výsledky: Neurologické symptómy so štrukturálnymi zmenami (MRI) mozgu osem mesiacov po infekcii naďalej pretrvávajú, pacienti môžu mať ťažké psychické poruchy. U (GBS) môžu potvrdiť (PNS) a vylúčiť poruchu v (CNS).

Záver: Časť pacientov po infekcii SARS-CoV-1 a MERS sa nevráti do normálnej kvality života a pociťuje neurologické a psychiatrické komplikácie až roky po akútnej infekcii po prekonaní COVID-19. Môžu mať neurologické, senzorické, muskuloskeletálne a neuropsychiatrické poruchy. Vek nad 65 rokov, chronické ochorenie pľúc, kardiovaskulárne ochorenie, hypertenzia, cukrovka a obezita sú rizikové faktory komplikácií súvisiacich s infekciou SARS-CoV-2. MRI vyšetrenie mozgu po prekonaní COVID-19 môže zobrazit štrukturálne zmeny, po ktorých pretrvávajú dlhodobé neurologické, senzorické, muskuloskeletálne a neuropsychiatrické poruchy.

Kľúčové slová: Postcovidový syndróm, nervový a senzorický systém, muskuloskeletálne a neuropsychiatrické poruchy, štrukturálne zmeny MRI mozgu.

INTRODUCTION

Recognizing nervous system disease associated with COVID-19 is challenging. Neurological disorders occur in the central nervous system (CNS), and peripheral nervous system (PNS). Inflammation alters neurotransmitters in the brain — serotonin, norepinephrine, dopamine — that allow nerve cells to communicate. Patients with depression have high levels of inflammation and anxiety, a history of stress, associated illnesses, and isolation as consequences of COVID-19. The prevalence of neurological and mental illness in athletes has also been confirmed by the impact of repeated blows to the head. When studying the impact on the nervous and sensory system in post-COVID syndrome, it is necessary to distinguish between complications such as hypoxic encephalopathy, acute neuropathy including infectious, parainfectious, and post-infectious encephalitis. After overcoming COVID-19, complications include hyper-coagulable states, diseases of the nervous and cardiovascular systems, metabolic, immune, and endocrine system disorders.

OVERVIEW OF POSTCOVID SYNDROME PUBLICATIONS

The nervous system diseases associated with COVID-19 and the effects of coronavirus on the nervous system led to neurological and psychiatric diseases (Varatharaj et al. 2020). Changes have been described in neurodegenerative diseases, demyelinating diseases, encephalopathies, encephalitis, neuropsychiatric diseases, psychosis, neurocognitive syndrome type dementia, and affective disorders (Ellul et al. 2020). Thrombosis, inflamed epithelium, and blood-brain barrier disorders may contribute to brain damage with COVID-19. Neurological disorders can arise as a result of a severe systemic response to a viral disease outside the nervous system. Meningitis and encephalitis associated with COVID-19 suggest that SARS-CoV-2 may directly infect the nervous system (Chen et al. 2020). Contributing factors include secondary hypoxia, cytokine-related damage, and retrograde transit through the olfactory nerve and bulb (Kumar et al. 2020). A proportion of patients after SARS-CoV-1 infections do not return to a normal quality of life and experience neurological complications years after acute infection (Fotuhi et al. 2020). They may have neurological, sensory, musculoskeletal, or neuropsychiatric manifestations (Duran et al. 2021). Frontal lobe brain disorders are non-specific and are prevalent in individuals with encephalopathy (Rass et al. 2021). Central nervous system (CNS) symptoms have been reported in 36.4 % of COVID-19 cases, peripheral nervous system (PNS) symptoms in 8.9 %, and skeletal muscle symptoms in 10.7 % (Collantes et al. 2021).

In a study of 63 consecutive stroke patients with NCPM, where NCPM associated with COVID-19 was classified as

a case, and NCPM unrelated to COVID-19 as a control. 19/63 (28.8 %) had NCPM with COVID-19, 11/63 (17.5 %) were hemorrhagic, and 52/63 (82.5 %) were ischemic. NCPM associated with COVID-19 was more severe and had a higher risk of severe disability and/or death. Patients with COVID-19 associated NCPM who developed it during hospitalization had more severe NCPM than those who developed it during hospitalization for NCPM (Immovilli et al. 2022).

Guillain-Barre syndrome (GBS) was the most common neurological disorder (21.8 %), with cerebrovascular palsy NCPM (16.4 %) and optic neuritis (Jaafar et al. 2022) remaining latent in the nervous system for a longer period of time after SARS-CoV-2, making it able to reactivate and cause neurological problems (Coronado et al. 2021).

Age over 65 years, chronic lung disease, cardiovascular disease, hypertension, diabetes, and obesity are risk factors for complications related to SARS-CoV-2 infection (Nuzzo et al. 2021). Neurological symptoms of COVID-19 are anosmias, agenesia, encephalopathy, encephalitis, myelitis, GBS, plexopathy, and cranial neuropathy (Dalakas et al. 2020). Disorders that did not occur prior to COVID-19 occurred in one in six patients, including polyneuro/myopathy, mild encephalopathy, parkinsonism, orthostatic hypotension associated with vasovagal syncope, and stroke (Rass et al. 2021). The analysis included post-infectious neurological complications: GBS, transverse myelitis, neuromyopathy, NCPM, encephalopathy, optic neuritis, Opsoclonus myoclonus syndrome (OMS), vestibular neuritis, myopathy, Bell's palsy, status epilepticus, and parkinsonism (Jaafar et al. 2022). The risks in patients due to SARS-CoV-2 acute respiratory syndrome vary according to age and comorbidity (Varatharaj et al. 2020). The virus has a long-standing role as an initiator of neurodegenerative diseases (Kumar et al. 2021) such as encephalopathy, encephalitis, neuropsychiatric diseases, psychosis, neurocognitive disorders such as dementia, and affective disorders (Ellul et al. 2020). Neurological disorders are preceded by cough and fever, with irritability, confusion, and impaired consciousness, associated with seizures (Bernard-Valnet et al. 2020; Sohal et al. 2020). Seizures in patients with COVID-19 suggest viral invasion of the central nervous system. A seizure is a symptom of acute brain damage induced by hypoxaemia due to pneumonia. Metabolic abnormalities and septic encephalopathy are prominent. Patients who have a history of status epilepticus have a poorer prognosis. Seizure frequency may increase due to a lower threshold of irritability CNS (Coronado et al. 2021), postinfectious status epilepticus (Jaafar, et al. 2022), psychotic symptoms (Vollono et al. 2020), renomination (Wong et al. 2020), immuno-compromised encephalitis with COVID-19 infection, encephalopathy, changes in personality, behavior, cognition, impaired consciousness, delirium, coma (Slooter, et al., 2020), acute disseminated encephalomyelitis, multifocal demyelinating syndrome (Dugue et al. 2020; Helms et al. 2020; Mao, et al. 2020; Paniz-Mondol et al. 2020;

Zhou et al. 2020), acute hemorrhagic necrotizing encephalopathy, and myelitis (Zhao et al. 2020). The causes of encephalopathy in patients who have not had COVID-19 may be hypoxia, medications, drugs, toxins, or metabolic disorders. The PNS disorders associated with COVID-19 are GBS, acute polyradiculopathy with progressive symmetric limb weakness and sensory disturbances, loss of facial nerve sensation, dysphagia, respiratory failure (Zhao et al. 2020), ophthalmoplegia, ataxia and areflexia, vestibular syndrome, rhabdomyolysis, and Miller Fisher syndrome. Neurological disorders are more common (Chen et al. 2020) and over time (Carfi et al. 2020). Neuropsychiatric disorders, anosmia, agnosia, dysgeusia, headaches, muscle and joint pain, fatigue, and brain fog can persist for months and lead to delirium and psychosis, inflammatory syndromes, NCPM (Rudroff et al. 2020; Morgul et al. 2020; Satici, et al. 2020; Iadecola et al. 2020), headaches and cognitive impairment including mental confusion, delirium and dementia (Liotta et al. 2020). Encephalopathy occurs in older people with pre-existing chronic illnesses (Nuzzo et al. 2021). Cognitive decline and dementia in people over 60 years of age with a predisposition to cerebrovascular disease, arterial hypertension, diabetes, and dyslipidemia have a higher risk of ischemic stroke during COVID-19 (Qureshi et al. 2020). PNS, acute neuropathy and polyneuropathy, and GBS cause nerve damage with progressive loss of muscle strength, with respiratory muscles also affected (Webb et al. 2020). When walking, weakness of the lower limbs, lack of muscle strength in the pelvic plexus, cutaneous hyperalgesia, drowsiness, malaise, diffuse hypotension, and weakness of the limbs are observed. Absence of bed rest and immobilization causes muscle decline, chronic fatigue, headaches, paresthesias of the fingers, anxiety and depression. Patients with severe respiratory diseases experienced dizziness, headaches, and impaired consciousness. Acute disseminated encephalomyelitis, multifocal demyelinating syndrome (Dugue et al. 2020; Helms et al. 2020; Mao et al. 2020; Paniz-Mondol et al. 2020; Zhou et al. 2020), acute hemorrhagic necrotizing encephalopathy, and myelitis occurred (Zhao et al. 2020), PNS disorders associated with COVID-19 include: GBS, acute polyradiculopathy with progressive symmetrical limb weakness and sensory disturbances, sensory loss, facial nerve dysfunction, visual disturbances, dysphagia, respiratory failure (Zhao et al. 2020), ophthalmoplegia, ataxia and areflexia, acute vestibular syndrome, rhabdomyolysis, and Miller Fisher syndrome. Inflammatory eye disease may be the first sign of COVID-19. Red eyes are a symptom of emerging tumors of the eye, orbit, and accessory organs (Furdova et al. 2020). Patients with a severe form of COVID-19 had persistent feelings of physical and mental fatigue, muscle weakness, drowsiness, lack of focus, and decreased cognitive function. They perceived physical exhaustion and experienced feelings of fatigue and lack of energy. They affect their daily lives (Carfi et al. 2020; Goertz et al. 2020). GABAergic dysfunction explains apathy/fatigue and performance deficits (Orteli et al. 2020), dysexecutive syndrome (Orteli et al. 2020; Helms et al. 2020). The COVID-19 has

a negative impact on motivational aspects, and a direct correlation between apathy and depression has been found. In the acute phase of COVID-19, a hyperinflammatory state developed, associated with central and peripheral nervous system complications. Altered mental status, psychosis, affective disorders, neurocognitive disorders (similar to dementia), headache, encephalitis, myelitis, myopathy and/or myositis, GBS, mononeuritis/multineuritis (Filosto et al. 2020; Korallnik et al. 2020; Romero-Sanchez et al. 2020; Zhao et al. 2020). Six months after symptom onset, patients presented with fatigue, muscle weakness, sleep problems, anxiety, and depression. In the severe course of the disease, the lung diffusion capacity decreased (Huang et al. 2021). Hyperinflammation and endotheliitis disrupt the blood-brain barrier (Najjar et al. 2020). Virus increases hypercoagulability through mechanisms and interrelationships between thrombosis and inflammation (Wang et al. 2020). The post-COVID-19 neurological syndrome (PCNS) is with prolonged muscle weakness and forms of myopathy (Wijeratne et al. 2020c). A study of a previous SARS epidemic reported active central nervous system involvement and chronic fatigue even after four years of infection (Chan et al. 2003; Lam et al. 2009). Patients with severe respiratory disease experienced dizziness, headache and impaired consciousness. COVID-19 in physicians with COVID-19 has been associated with varying degrees of depression, sleep disturbances, and anxiety in whom studies have shown signs of severe posttraumatic stress disorder (PTSD) (Bo et al. 2020). Asymptomatic or mildly symptomatic patients experience muscle pain, dizziness, headache, fatigue, and anosmia for several months in the long term (Goertz et al. 2020). The neurotropism of SARS-CoV-2 is unclear (Harapan et al. 2021 Neurological symptoms with changes (MRI) were eight months after infection (Nuzzo et al. 2021). MRI of the brain detected hyperintense areas in the periventricular and subcortical white matter and centrum semiovale. After five months, neurological disturbances appeared along with depression and seizures (Nuzzo, et al. 2021).

MATERIAL AND METODS

Similar changes on MRI were observed in an unconscious, ventilated patient with an epileptic seizure 2 days after contact with COVID-19. Infratentorially in the midbrain peduncles and supratentorially predominantly in the paraventricular white matter, hyperintense areas with microvascular etiology were present bilaterally. Parietally, paramedially on the right in the subcortical white matter, a hemosiderin deposit up to 11 mm in size is visible (Fig. 1). Repeat MRI after 3 months showed small deposits in the white matter, most prominent in the occipital paraventricular left, up to 6 mm in diameter. Frontal lymphatic spaces dilated bilaterally, with a more pronounced Sylvian furrow reaching 13 mm in width (Fig. 2). After intensive rehabilitation, sleep disturbance, general weakness, and fatigue persisted after 6 months in the MRI image (Fig. 3).

The patient's MRI images are arranged in chronological order, from left to right: 14. 3. 2022 (14 days after coma), 1. 6. 2022 (follow-up after 3 months), and 1. 9. 2022 (follow-up after 6 months).

Slight differences are due to the use of different MRI machines and settings for each sequence, yet they compare well with each other.

Despite the prominent neurological manifestations, the MRI image did not pick up morphological changes on any of the sequences to explain them; there were no signs suggestive of viral encephalitis, NCMP, meningitis, dural venous sinus, or other pathology. Stationary small and unchanging foci of gliosis in the white matter of microvascular etiology or changes of "aging brain" were present. A stationary minor striated cortical hemosiderin (older hemorrhage) deposit was noted parietally to the right (Fig. 4).

Figure 1: FLAIR (T2 TIRM) sequence at the level of the basal ganglia

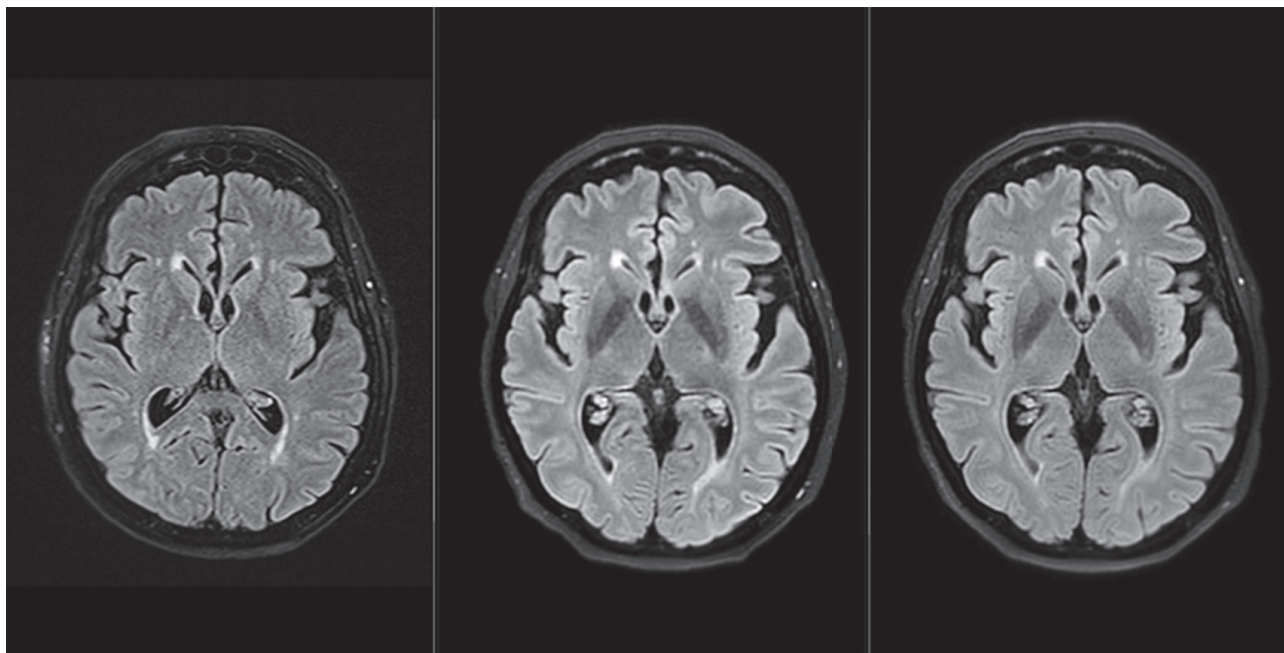
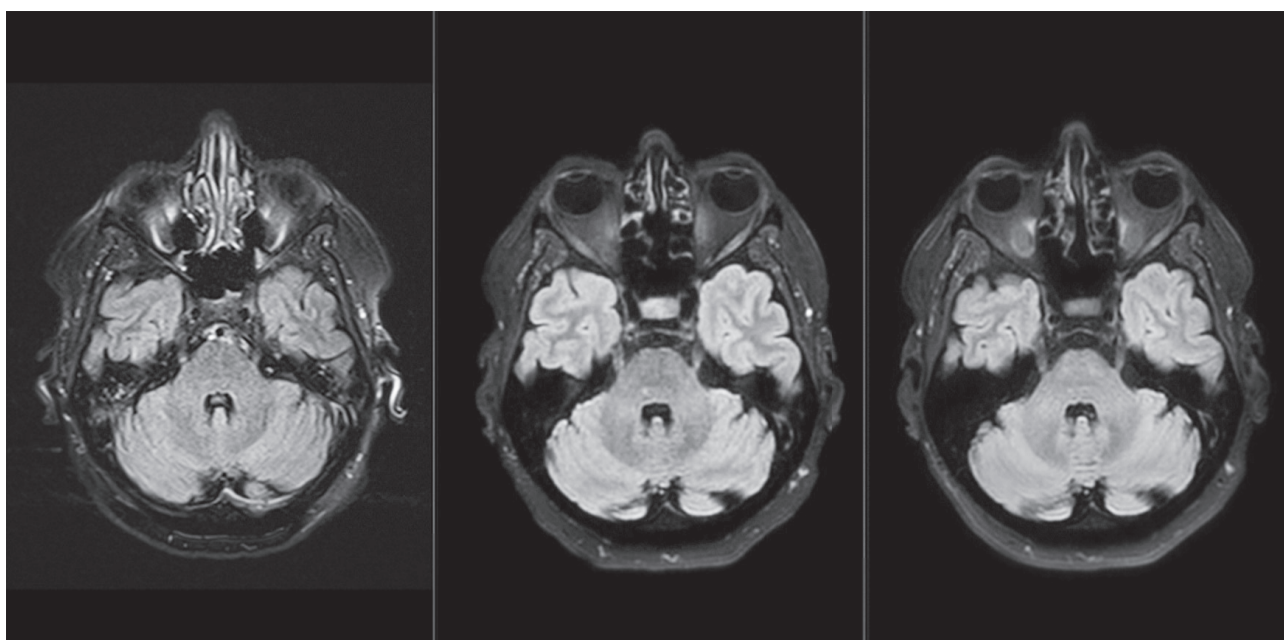


Figure 2: FLAIR (T2 TIRM) sequence at brainstem level



Patient with mild course, olfactory disturbance, HK weakness, fatigability, tearfulness, after 3 months, persistent weakness, fatigability, sleep disturbance, depression, unreasonable tearfulness, phobia before MRI scan that she will die, and aggressiveness, panic fear, aggressive behavior, which disrupted the MRI scan, was placed under the care of a psychiatrist. After missing spa treatment for three months, a repeat MRI for post-COVID syndrome is scheduled.

The patient with GBS underwent an MRI examination of the brain 3-month follow-up. The control in the area of the brain did not show any dynamics of the monitored, highly likely chronic changes: mostly smaller foci in the white matter (Fig. 5), without a correlation (Fig. 6), morphologically apparently small foci of microvascular gliosis.

MRI can differentiate between peripheral GBS and central disorders of the CNS in patients with vestibular disorders, dizziness, balance, and orientation in space.

Figure 3: DWI (b800) sequence at basal ganglia level

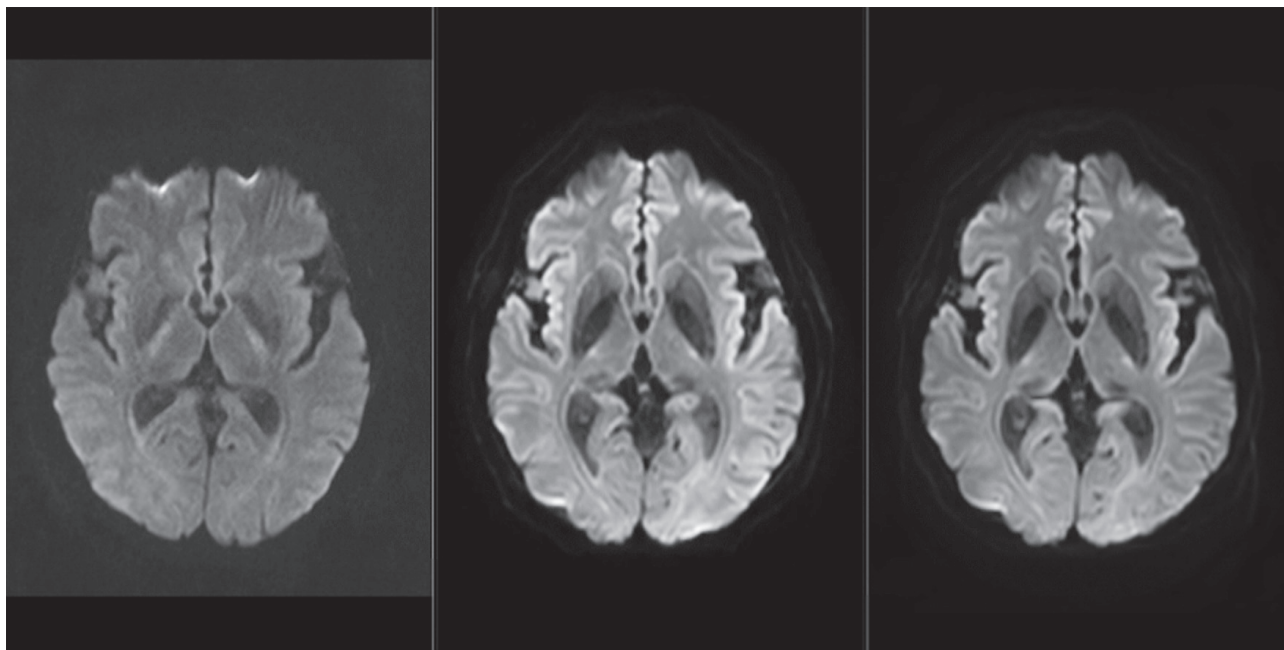
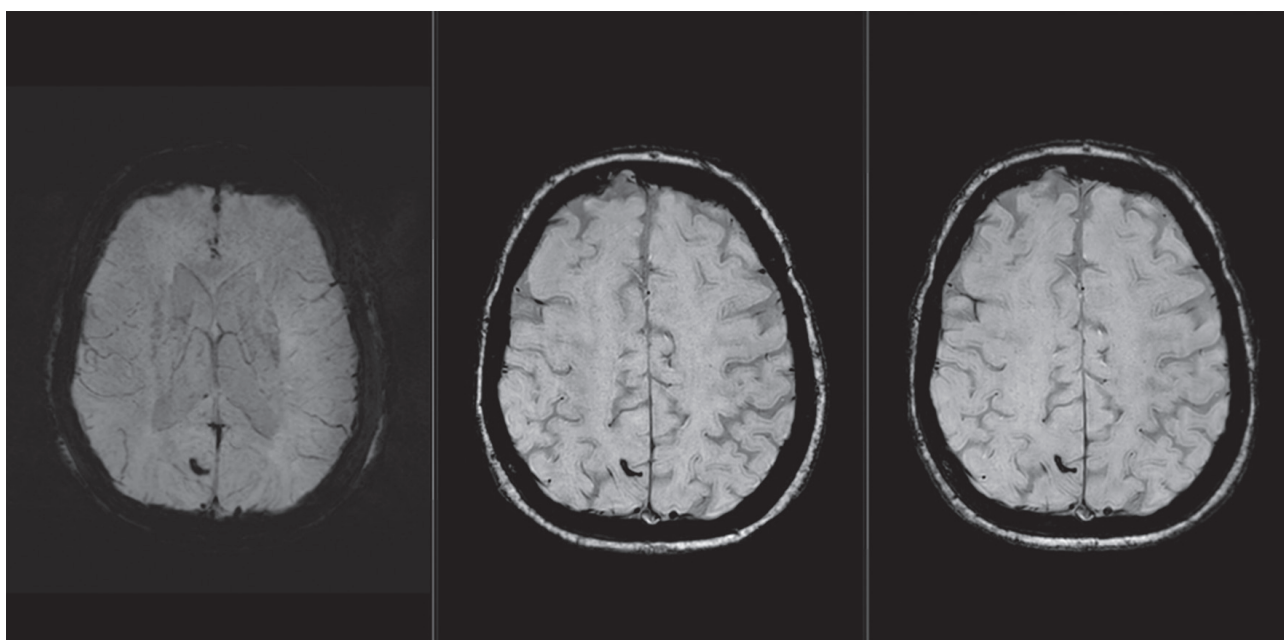


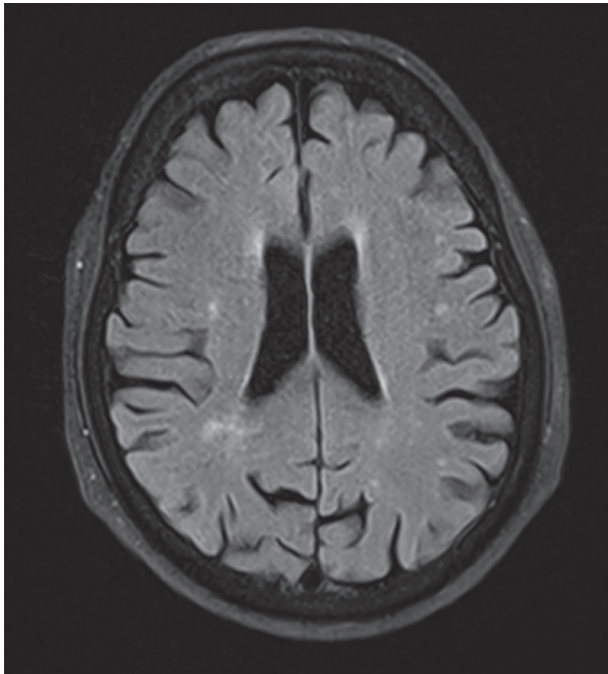
Figure 4: SWI sequence at the level just above the ceiling of the lateral ventricles



RESULTS AND DISCUSSION

We present a review and analysis of the impact of COVID-19 on the nervous and sensory system. COVID-19 induces long-lasting neurological, sensory, musculoskeletal, and neuropsychiatric disorders. MRI brain scans show structural changes that result in neurological, sensory, and neuropsychiatric disturbances after COVID-19. The

Figure 5: MRI examination (FLAIR)



CONCLUSION

A proportion of patients after SARS-CoV-1 and MERS infection do not return to a normal quality of life and experience neurological and psychiatric complications years after acute infection after overcoming COVID-19. They may have neurological, sensory, musculoskeletal, or neuropsychiatric disorders. Age over 65 years, chronic lung disease, cardiovascular disease, hypertension, diabetes, and obesity are risk factors for complications related to SARS-CoV-2 infection. After COVID-19, a brain MRI scan causes structural changes that result in neurological, sensory, musculoskeletal, and neuropsychiatric disorders that last for a long time. MRI can differentiate between peripheral GBS and central disorders of the CNS in patients with vestibular disorders, dizziness, balance, and orientation in space.

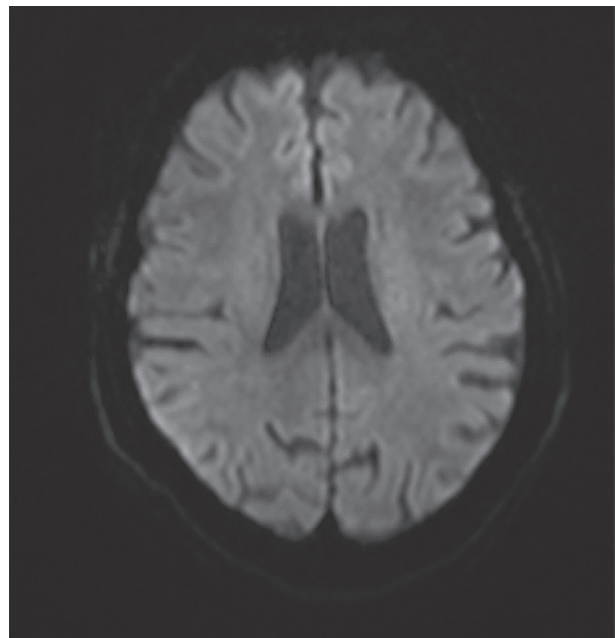
Conflict of interest: None

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disturbances persist for months or years after COVID-19. MRI can differentiate between peripheral GBS and central disorders of the CNS in patients with vestibular disorders, dizziness, balance, and orientation in space.

Neurological symptoms with structural changes (MRI) of the brain continue to persist eight months after infection and may cause severe psychiatric disturbances. GBS can confirm PNS and exclude a disorder in the CNS.

Figure 6: MRI examination (DWI- b800); after 3-month follow-up without changes on both sequences



REFERENCES

1. Bernard — Valnet R, Pizzarotti B, Anichini A, et al. (2020). Two patients with acute meningo-encephalitis concomitant to SARS-CoV-2 infection. *Eur J Neurol.*, <https://onlinelibrary.wiley.com/doi/abs/10.1111/ene.14298>
2. Bo H. X, Li W, Yang Y, Wang Y, Zhang Q, Cheung T, et al. (2020). Post-traumatic stress symptoms and attitude toward crisis mental health services among clinically stable patients with COVID-19 in China. *Psychol. Med.*, 1 — 2.
3. Carfi A, Bernabei R, Landi F. (2020). Gemelli Against COVID-19 Post-Acute Care Study Group. Persistent Symptoms in Patients After Acute COVID-19. *JAMA*, 324: 603 — 605.
4. Collantes M. E, Espiritu A. I., Sy M. C., Anlacan V. M, Jamora R. D. (2021). Neurological manifestations in COVID-19 infection: a systematic review and meta-analysis, *Can. J. Neurol. Sci.* 48 (1): 66 — 76.
5. Dalakas M. C. (2020). Guillain-Barré syndrome: the first documented COVID-19-triggered autoimmune neurologic disease: more to come with myositis in the of ng, *Neurology-Neuroimmunology Neuroinflammation.* 7 (5) 781.

6. Dugue R, Cay-Martínez KC, Thakur KT, et al. (2020). Neurologic manifestations in an infant with COVID-19. *Neurology*, 94(24): 1 100—1 102.
7. Duran J. C, Duran J. P. (2021). Post COVID-19 neurological syndrome: a prospective study at 3 600 m above sea level in La Paz Bolivia. *J. Neurol. Sci.* 429: 119—610.
8. Ellul M, Benjamin L, Singh B, Lant S, Michael B. D, Easton A, et al. (2020). Neurological associations of COVID-19. *Lancet Neurol.* 19(9): 767—783.
9. Filosto M, et al. (2020). Guillain-Barré syndrome and COVID-19: an observational multicentre study from two Italian hotspot regions. *J. Neurol. Neurosurg. Psychiatry*, 1—6.
10. Fotuhi M, Mian A, Meysami S, Raji C. A.(2020). Neurobiology of COVID-19 J. *Alzheim. Dis.* 76 (1): 3—19
11. Furdová A, et al. (2020). Melanómy oka a očných adnexov. Bratislava: Veda, Vydavateľstvo slovenskej akadémie vied. 2020. s.
12. Goërtz Y. M, Van Herck M, Delbressine J. M, Vaes A. W, Meys R, Machado F. V, et al. (2020). Persistent symptoms 3 months after a SARS-CoV-2 infection: the post-COVID-19 syndrome? *ERJ Open Res.*, 6(4).
13. Harapan B. N, Yoo H. J. (2021). Neurological symptoms, manifestations, and complications associated with severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) and coronavirus disease 19 (COVID-19). *J. Neurol.*, doi: 10.1007/s00415-021-10406-y.
14. Helms J, Kremer S, Merdji H, Clere-Jehl R, Schenck M, Kummerlen C, et al. (2020). Neurologic features in severe SARS-CoV-2 infection. *N. Engl. J. Med.* 382 (23): 2 268—2 270
15. Huang C, Huang L, Wang Y, Li X, et al. (2021). 6-month consequences of COVID-19 in patients discharged from hospital: a cohort study. *Lancet*, 397(10 270): 220—232. doi: 10.1016/S0140-6736(20)32658
16. Chan K, Zheng J, Mok Y, Li Y, et al. (2003). SARS: prognosis, outcome and sequelae. *Respirology*, 8: S36—S40.
17. Chen N, Zhou M, Dong X, Qu J, et al. (2020). Epidemiological and clinical characteristics of 99 cases of 2019 novel coronavirus pneumonia in Wuhan, China: A descriptive study. *Lancet*, 395: 507—513.
18. Chen X, Laurent S, Onur O. A, Kleiberg N. N, Fink G. R, Schweitzer F, et al. (2020). A systematic review of neurological symptoms and complications of COVID-19. *J. Neurol.* 268: 392—402.
19. Iadecola C, Anrather J, Kamel H. (2020). Effects of COVID-19 on the Nervous System. *Cell*, 183: 16—27.e1.
20. Immovilli P, Marchezi E, Terracciano Ch, Moreli N, Bazzurri V, Magnifico F, Zaino D, Terlizzi E, De Mitri P, Vollaro S, Momentto N, Guideti D. (2022). A “Post-mortem” of COVID-19-Associated Stroke: a Case-control Study. *Journal of Stroke Cerebrovascular Diseases*. 2022 <https://doi.org/10.1016/j.jstrokecerebrovasdis.2022106716>
21. Koralnik I. J, Tyler K. L. (2020). COVID-19: a global threat to the nervous system. *Ann. Neurol.*, 88(1): 1—11.
22. Kumar J, Makheja K, Rahul F. N, Kumar S, Kumar M, Chand M, et al. (2021). Long-term neurological impact of COVID-19. *Cureus* 13 (9): 18131.
23. Lam M. H, Wing Y. K, Yu M. W, Leung C. M, et al. (2009). Mental morbidities and chronic fatigue in severe acute respiratory syndrome survivors: long-term follow-up. *Arch. Int. Med.*, 169: 2 142—2 147.
24. Liotta E. M, Batra A, Clark J. R, Shlobin N. A, Hoffma S. C, Orban Z, Koralnik I. J. (2020). Frequent neurologic manifestations and encephalopathy-associated morbidity in COVID-19 patients. *Ann. Clin. Transl. Neurol.*, 7: 2 221—2 230.
25. Mao L, Jin H, Wang M, et al. (2020). Neurologic manifestations of hospitalized patients with coronavirus disease 2019 in Wuhan, China. *JAMA Neurol*, 77(6): 683—690.
26. Morgul E, Bener A, Atak M, Akyl S, Aktas S, Bhugra D, Ventriglio A, Jordan TR. (2020). COVID-19 pandemic and psychological fatigue in Turkey. *Int. J. Soc. Psychiatry*, 1—8.
27. Najjar S, Najjar A, Chong D. J, Pramanik B. K, Kirsch C, Kuzniecky R. I, et al. (2020). Central nervous system complications associated with SARS-CoV-2 infection: integrative concepts of pathophysiology and case reports. *J. Neuroinflammation*, 17 : 231.
28. Nuzzo D, Vasto S, Scalisi L, Cottone S, Cambula G, Rizzo M, et al., (2021). Post-acute COVID-19 neurological syndrome: a new medical challenge. *J. Clin. Med.* 10 (9): 1947.
29. Nuzzo D, Cambula G, Bacile I, et al. (2021). Long-Term Brain Disorders in Post Covid-19 Neurological Syndrome (PCNS) Patient. *Brain Sci.*, 11(4): 454.
30. Orтели P, Ferrazzoli D, Sebastianelli L, et al. (2020). Neuropsychological and neurophysiological correlates of fatigue in post-acute patients with neurological manifestations of COVID-19: Insights into a challenging symptom. *J Neurol Sci.* 420: 117271. doi:10.1016/j.jns.2020117271
31. Paniz-Mondol A, Bryce C, Grimes Z, et al. (2020). Central nervous system involvement by severe acute respiratory syndrome coronavirus-2 (SARS-CoV-2). *J Med Virol.*, 92: 699—702.
32. Qureshi A. I, Abd-Allah F, Al-Senani F, Aytac E, Borhani-Haghighi A, Ciccone A, Gomez C. R, Gurkas E, Hsu C. Y, Jani V, et al. (2020). Management of acute ischemic stroke in patients with COVID-19 infection: Report of an international panel. *Int. J. Stroke*, 15: 540—554.
33. Rass V, Beer R, Schiefecker A. J, Koher M, A. Lindner A, Mahlknecht P, et al., (2021). Neurological outcome and quality of life 3 months after COVID-19: a prospective observational cohort study. *Eur. J. Neurol.* 28 (10) 3 348—3 359.
34. Rawezh Q. S, Berwn A. A, Fattah H. R, Shvan H. M, Razhan K. A, Abdulwahid M. S. (2022). Systematic Review/Meta-analysis Post COVID-19 neurological complications; a meta-analysis. *Annals of Medicine and Surgery* 76: 103440
35. Romero-Sanchez C. M. et al. (2020). Neurologic manifestations in hospitalized patients with COVID-19: the ALBACOVID registry. *Neurology*, 95(8): e1060—e1070.
36. Rudroff T, Fietsam A. C, Deter J. R, Bryant A. D, Kamholz J. (2020). Fatigue: Potential Contributing Factors. *Brain Sci.*, 10, 1012.
37. Ružický E, Šrámka M, Lacko J, Mašán J, Rottermund J, Krčmery V. (2022) Providing prevention, diagnosis, and treatment of patients after COVID-19 using artificial intelligence. *Neuro Endocrinology Letters*. 2022 Apr; 43(1), pp. 9—17
38. Ružický E, Šrámka M, Lacko J, Mašán J (2022). Use of virtual reality for stress reduction in nanoarthroscopy. *Cybernetics & Informatics (K&I) 2022, 31st International IEEE Conference on Cybernetics and Informatics 22*, pp. 1—5.
39. Satici B, Gocet-Tekin E, Deniz M. E, Satici S. A. (2020). Adaptation of the Fear of COVID-19 Scale: Its Association with Psychological Distress and Life Satisfaction in Turkey. *Int. J. Ment. Health Addict.*, 1—9.
40. Slooter A. J, Otte W. M, Devlin J. W, et al. (2020). Updated nomenclature of delirium and acute encephalopathy: statement of ten Societies. *Intensive Care Med.*, 46: 1 020—1 022.
41. Sohal S, Mossammat M. (2020). COVID-19 presenting with seizures. *IDCases.*, 20: e00782.
42. Šrámka M, Mašán J, Ružický E. (2021). Nervous System and Post-Covid Syndrome. *Int J Health, NewTech, Soc Work*, 16(4): 69—70. ISSN 1336-9326, e-ISSN 2 644—5 433

43. Šrámka M, Slávik J, Mašán J, Ružický E. (2020b). Possible consequences of Covid-19 on the nervous system. *Neuroendocrinol Lett*, 41(4): 101 — 107. ISSN 0172-780X 34 COVID-19 and Its Impacts on Health, Helping Professions and New Technologies
44. Varatharaj A, Thomas N, Ellul M, et al. (2020). UK-wide surveillance of neurological and neuropsychiatric complications of COVID-19: the first 153 patients. SSRN, 3601761.
45. Vollono C, Rollo E, Romozzi M, et al. (2020). Focal status epilepticus as unique clinical feature of COVID-19: a case report. *Seizure*, 78: 109 — 112.
46. Wang T, Chen R, Liu C, Liang W, Guan W, Tang R, et al. (2020). Attention should be paid to venous thromboembolism prophylaxis in the management of COVID-19. *Lancet Haematol.*, 7: e362 — e363.
47. Webb S, Wallace V. C, Martin-Lopez D, Yogarajah M. G. (2020). Guillain-Barré syndrome following COVID-19: A newly emerging post-infectious complication. *BMJ Case Rep.*, 13: e236182.
48. Wijeratne T, Sales L, Karimi S. G. (2020a). Acute ischemic stroke in COVID-19: a case-based systematic review, *Front. Neurol.*, 11: (1031).
49. Wijeratne T, Sales S. G, et al. (2020b). First Australian case of good recovery of a COVID-19 patient with severe neurological symptoms post prolonged hospitalization, *Cureus*, 12(9): 10 366 — 10 377.
50. Wijeratna T, Crewthera S. (2020c). Post-COVID 19 Neurological Syndrome (PCNS); a novel syndrome with challenges for the global neurology community. *Journal of the Neurological Sciences.*, 419(2020): 117 — 179.
51. Wong P. F, Craik S, Newman P, et al. (2020). Lessons of the month 1: a case of rhombencephalitis as a rare complication of acute COVID-19 infection. *Clin Med*, 20(3): 293 — 294.
52. Zhao H, Shen D, Zhou H, Liu J, Chen S. (2020). Guillain-Barré syndrome associated with SARS-CoV-2 infection: causality or coincidence? *Lancet Neurol.*, 19(5): 383 — 384.
53. Zhou L, Zhang M, Wang J, Gao J. (2020). Sars-Cov-2: underestimated damage to nervous system. *Travel Med Infect Dis.*, 36: 101642.

Effective options for support of the therapeutic healing process in patients with breast cancer in the post-COVID era

Efektívne možnosti podpory liečebného uzdravovacieho procesu u pacientok s rakovinou prsníka v postcovidovom období

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ABSTRACT

Introduction: A special survey of patients who had gone through the breast cancer treatment process was carried out in the period from October 2021 to August 2022. The survey took place in various countries with the participation of 150 women aged 35-70.

Material and methods: The survey was carried out based on qualitative research strategies by means of deep online interviews. The aim of this special survey was to find out what problems women with breast cancer encountered during their treatment and after the treatment.

Results: Respondents stated that during their participation in the intervention program they felt some decrease in their feelings of anxiety and stress, as well as some increase in sleep level quality. After completing the intervention program, they stated in the survey also some kind of new perception of themselves and a determination to carry out positive changes in their lives or at work.

Conclusion: Similarly designed special online trainings for effective management strategies should be intensively developed and modified to make them applicable also in the case of treatment support for other oncological diseases.

Keywords: Cancer. Treatment support. Logotherapeutic principles.

Úvod: V období od októbra 2021 do augusta 2022 bol realizovaný špeciálny prieskum s pacientkami, ktoré podstúpili liečbu rakoviny prsníka. Prieskum sa uskutočnil v rôznych zahraničných krajinách a zúčastnilo sa ho 150 žien vo veku od 35-70 rokov.

Materiál a metodika: Prieskum bol realizovaný na základe kvalitatívnych výskumných stratégií prostredníctvom hĺbkových online rozhovorov. Zámerom špeciálneho prieskumu bolo zistiť s akými problémami sa ženy s rakovinou prsníka stretli v priebehu liečby a po liečbe.

Výsledky: Respondentky uviedli, že počas účasti na intervenčnom programe sa u nich znížili pocity úzkosti a stresu a zlepšila sa im aj kvalita spánku. Po absolvovaní intervenčného programu počas prieskumu uvádzali taktiež nové vnímanie seba samých a odhodlanie k pozitívnym zmenám v ich živote alebo v práci.

Záver: Podobne vytvorené špeciálne tréningy ako efektívne stratégie zvládania by sa mali viac rozvíjať a modifikovať, aby mohli byť aplikovateľné aj v prípade podpory liečby iných onkologických ochorení.

Kľúčové slová: Rakovina. Podpora liečby. Logoterapeutické princípy.

INTRODUCTION

Although the process of breast cancer treatment is often successful, it strongly affects the ability of patients to mentally adapt to effectively managing the disease, and their ability to cope with it emotionally. This is reflected, for example, in emotional anxiety and perception of own identity or self-notion (Hajian, Mehrabi, Simbar, Houshyari 2017; Khalili, Farajzadegan, Mokarian, Bahrami 2013). With the aim of decreasing anxiety and stress levels after completed treatment of breast cancer, a survey was carried out in Great Britain, Romania, Poland, Hungary, Italy, Spain, Austria, the USA and Serbia. The focus of this special survey was on understanding what problems women with breast cancer encountered during their treatment and after it. A special intervention program, involving cognitive rehabilitation and some logotherapeutic principles, such as the logotherapeutic principle of a common denominator, as well as the logotherapeutic principle of dereflection, was created for the respondents during the treatment process. Its objective was to help patients decrease the anxiety and stress levels accompanying the breast cancer treatment process, the period after the treatment, as well as any symptoms of post-COVID syndrome, which became chronic for many of these women.

METHODS AND RESULTS

The survey was carried out from October 2021 to August 2022, with the participation of 150 women aged 35–70. The criteria for inclusion in the survey was completed treatment — surgical, chemotherapeutical, or radio-therapeutical, while a period of at least one year had to have passed since treatment. A qualitative research design was used for receiving the answers from the respondents. An advantage of this research strategy is that it strives to understand the individual and to understand theoretical constructs relevant between

individuals. The story of each participant reflects a unique point of view on the researched issue (Tracy 2019). A deep online interview was used as a tool. Each interview lasted 80 minutes. The survey participants were contacted thanks to organizations and assistance groups focused on breast cancer by means of informational material on the survey. Potentially interested participants were subsequently asked to contact the researchers via e-mail or an application. Prior to carrying out the interview, potential respondents completed three online meetings, during which they received all instructions on and details about the survey, as well as its future outputs. Additionally, the participants were also notified that their participation in the survey would be voluntary and that they were free to withdraw at any time or to not respond to any particular question if they felt uncomfortable. After that, they submitted their consent to participation in the survey and to the processing of their personal data. All addressed respondents participated to the fullest extent in the survey. The interviews were then analysed. The analysis compared and analysed data from the transcripts of interviews based on the strategy of eight steps for data analysis (Fife 2020) and all data on respondents were subject to the ethical rules of research and were kept in absolute anonymity. The trustworthiness of the carried out research was ensured by continuously delving into the analysis and organizing the analytical meetings with the auditors of the survey. All authors of the article participated in all phases of the survey. The objective of the survey was achieved through the subsequent research question:

Can a specially designed intervention program help in coping with anxiety and stress, and contribute to the improvement of perception of self-notion in women who have been through the breast cancer treatment process?

To some extent, the number of respondents in the survey was a limiting factor. For this reason, the research is continuing

from August 2022 and is focusing on more important aspects, which have serious consequences for women suffering from breast cancer, as well as on the methods capable of moderating the impact of breast cancer on the interpersonal relationships of women functioning within a family life with close or distant family members, and on which less used management strategies could possibly help women through the negative mental impacts of breast cancer.

The results of the survey demonstrate that, due to the disease being diagnosed, the self-image of the respondents changed, serious problems in marital and partner relationships occurred, and also their role as mother or grandmother changed — in this area, they experienced serious anxiety. Due to the problems accompanying the disease, they focused primarily on themselves as mothers, grandmothers, wives, and partners, and only after that did they realize, define, and fulfil their own needs. The respondents often expressed the need for psychological support and individual social support.

According to the respondents, after being diagnosed with the disease and during the treatment, the following problems occurred most often in their marital and partner relationships:

- unwillingness by or disinterest from one of the spouses/partners to communicate; problems related to the partner's family, including parents, siblings and other family members; problems related to assigning everyday duties (insufficient help in the household); financial problems due to the long-term working inability of respondents; problems in sexual life; receiving unrequested advice; loss of common objectives and interests; problems with processing emotional harm; free time spending and common time spending; dominance of a husband/partner arising from stress from work, unequal position in work or income, communication or caring for children; the "failure" of any family member; and, changes within the family, including positive changes. Gradual weakening of the ability of spouses/partners to communicate about any problem with the aim of decreasing the tension — from this arising the loss of an easy and quick finding of a compromise; loss of positive feelings; dominance towards each other due to the aforementioned factors.

During the survey, the respondents completed a specially designed training program comprised of twelve meetings organized by the researchers.

The training intervention program consisted of three main parts:

- The first part involved cognitive rehabilitation. The respondents completed a series of exercises focused on brain jogging by means of specially selected exercises, the aim of which was to achieve an improvement in cognitive and behavioural abilities, which had worsened as a consequence of post-COVID syndrome.

- The second part included common exercises with a husband/partner focused on strengthening the marital or partner relationship by applying some logotherapeutic principles, such as the logotherapeutic principle of a common denominator, and the logotherapeutic principle of dereflection.
- The third part of the program consisted of exercises focused on a positive self-image and self-acceptance, expressions of empathy towards oneself, training of positive emotions, joy, love, perception of the present moment, training of self-control, as well as various activities the aim of which was to occupy the attention of respondents and help them relax, to self-express and to communicate. This part of the program was amended by techniques of controlled slow breathing, which help to lower stress levels, anxiety, and depression. For example, by completing the training on correct and slow breathing, this led to physical and psychical relief; the respondents went through short meditation exercises focused on breathing and the body, thus helping to moderate tension, anxiety, and stress.

In this part of the intervention program, the respondents had the opportunity to participate also in therapeutic writing. The respondents also completed training on thankfulness and recognition connected with writing down positive experiences, the consequence of which being a positive effect on health, moderation of stress level, and support for a more optimistic view on life.

After completing this intervention program, the respondents went through the online meetings with researchers, during which they commonly assessed the effects of the program on their mental and emotional experiences. The respondents stated that, during their participation in the intervention program, they felt decreased anxiety and stress levels, along with improved sleep quality. According to their statements, the younger respondents experienced the highest levels of stress after being unexpectedly diagnosed, mainly due to fear of death and fear for their young children. Based on their statements, the fear that something negative would happen to their children still persists but, during the relaxation exercises within the program, they felt some relief from this stress. The respondents also stated that during the disease and its treatment they went through many changes. A significant change was often the fact that they realized their own mortality and that their life may end. According to their statements, the most minor problems were caused due to the need to change their appearance. Whilst completing the exercises in the online intervention program, significantly strengthening for them was realizing the present moment, realizing God's love given to every human, and the space where they could accept the truth about themselves in internal freedom and humility, without it negatively affecting their self-perception.

DISCUSSION

The respondents also expressed the need for increased emotional social support from their family members, and some need for a form of professional help, which would accompany them via deeper realization of the needs of their children or grandchildren, as well as their own individual needs. The respondents were aware that a priority for them was the needs of their loved ones, and their own needs came second.

After completing the intervention program, the respondents stated in the survey also some kind of new perception of themselves and a determination to carry out positive changes in their lives or at work. According to the respondents, after completing the intervention program, they felt stronger, bolder, and more satisfied in living their everyday life, and were interested to continuing with the online program with the aim of strengthening their own feelings of self-respect and mental well-being.

CONCLUSION

A specially designed intervention program with the features of cognitive rehabilitation and some logotherapeutic principles designed for women after successful treatment of breast cancer can be significantly helpful by processing various mental aspects accompanying the diagnosis and treatment of breast cancer. Similarly designed special online trainings for effective management strategies should be intensively developed and modified to make them applicable also in the case of treatment support for other oncological diseases. This, however, requires carrying out further similar studies with more extensive and more varied groups of respondents, which would include various levels of education and ethnicities for both women and men. Subsequently, these studies should be supported by more detailed systematic overviews of the specifics of such online trainings and their specific steps within the work with participants of empirical research, as well as the outcomes and direct possibilities of the application for participants.

Conflicts of interest

The authors declare no conflicts of interest.

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REFERENCES

1. Fife D (2020). The Eight Steps of Data Analysis: A Graphical Framework to Promote Sound Statistical Analysis. *Perspectives on Psychological Science* 2020; 15(4): 1 054—1 075. <https://doi.org/10.1177/1745691620917333>
2. Hajian S, Mehrabi E, Simbar M, Houshyari M (2017). Coping Strategies and Experiences in Women with a Primary Breast Cancer Diagnosis. *Asian Pac J Cancer Prev*. 2017; 18(1): 215—224. doi: 10.22034/APJCP.2017.18.1215.
3. Khalili N, Farajzadegan Z, Mokarian F, Bahrami F. (2013). Coping strategies, quality of life and pain in women with breast cancer. *Iran J Nurs Midwifery Res*. 2013; 18(2): 105—11.
4. Tracy, S J (2019). *Qualitative Research Methods: Collecting Evidence, Crafting Analysis, Communicating Impact*. 2nd ed. Wiley-Blackwell, 2019.

Gestalt therapy's contribution to social work guidance

Príspevok gestalt terapie ku sociálnemu poradenstvu

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ABSTRACT

Introduction: The article briefly explains the most important features of Gestalt therapy and the principles underlying Gestalt therapy. It will also discuss a study involving patients who have undergone treatment for breast cancer and who have experienced symptoms of post-COVID syndrome.

Material and methods: The research is being carried out in Italy and Poland in several centres focused on helping women suffering from breast cancer and its consequences, as well as on helping families. The aim is to investigate how social workers acting as Gestalt therapists can support patients. Two hundred women aged between 40 and 60 took part in the study. The study uses a qualitative approach in the form of semi-structured interviews.

Results: Based on the results of the research thus far, it can be concluded that patients treated for breast cancer with symptoms of post-COVID syndrome expect honesty, authenticity, reciprocity, tolerance, a non-judgmental attitude, responsibility and empowerment from social workers. Through human, honest and equal relationships, as well as through acceptance and understanding, the respondents gain confidence and thus achieve the conditions for change. As the respondents themselves have stated, such relationships foster awareness and responsibility. In addition, patients have reported that they would have appreciated the guidance of social workers during and after treatment in the form of Gestalt therapy. Patients have subjectively experienced alleviation of some of the symptoms of post-COVID syndrome, including moodiness, depression, nervousness, enhanced stress reactions and sleep problems. Various exercises under the guidance of a social worker acting as a Gestalt therapist induce a feeling of physical and psychological relaxation in the patients, which also improves their sleep patterns.

Conclusion: For further similar research, it is necessary to apply and develop a client-oriented model of guidance in social work based on humanistic and existential values, and the therapeutic aspects of social work. Furthermore, it is necessary to adapt training programmes for social workers, which should be supported by Gestalt therapy professionals. One way to implement such a model could be to apply the principles of Gestalt therapy to the practice of guidance in social work.

Keywords: Gestalt therapy. Guidance. Social work.

Úvod: Článok stručne vysvetľuje najdôležitejšie vlastnosti Gestalt terapie a princípy, ktoré sú základom Gestalt terapie. Diskutuje o štúdiu zahŕňajúcej pacientov, ktorí podstúpili liečbu rakoviny prsníka a pociťovali symptómy post-COVID syndrómu.

Materiál a metodika: Výskum prebieha v Taliansku a Poľsku vo viacerých centrách zameraných na pomoc ženám trpiacim rakovinou prsníka a jej následkami, ako aj na pomoc rodinám. Cieľom je zistiť, ako môžu sociálni pracovníci pôsobiaci ako Gestalt terapeuti podporovať pacientov. Štúdie sa zúčastnilo dvesto žien vo veku od 40 do 60 rokov. Štúdia využíva kvalitatívny prístup vo forme pološtruktúrovaných rozhovorov.

Výsledky: Na základe doterajších výsledkov výskumu možno konštatovať, že pacientky liečené na rakovinu prsníka s príznakmi post-COVID syndrómu očakávajú od sociálnych pracovníkov čestnosť, autenticitu, reciprocitu, toleranciu, neodsudzujúci prístup, zodpovednosť a splnomocnenie. Ľudskými, čestnými a rovnocennými vzťahmi, ako aj prijatím a porozumením získavajú respondenti dôveru a tým dosahujú podmienky na zmenu. Ako uviedli samotní respondenti, takéto vzťahy podporujú uvedomelosť a zodpovednosť. Okrem toho pacienti uviedli, že by ocenili vedenie sociálnych pracovníkov počas liečby a po nej vo forme Gestalt terapie. Pacienti subjektívne pociťovali zmiernenie niektorých symptómov post-COVID syndrómu, vrátane náladovosti, depresie, nervozity, zvýšených stresových reakcií a problémov so spánkom. Rôzne cvičenia pod vedením sociálneho pracovníka pôsobiaceho ako Gestalt terapeut navodzujú u pacientov pocit fyzického a psychického uvoľnenia, čím sa zlepšuje aj ich spánkový režim.

Záver: Pre ďalší podobný výskum je potrebné aplikovať a rozvíjať klientsky orientovaný model poradenstva v sociálnej práci založený na humanistických a existenciálnych hodnotách a terapeutických aspektoch sociálnej práce. Ďalej je potrebné prispôsobiť školiace programy pre sociálnych pracovníkov, ktoré by mali byť podporované odborníkmi z Gestalt terapie. Jedným zo spôsobov implementácie takehoto modelu by mohla byť aplikácia princípov Gestalt terapie do praxe poradenstva v sociálnej práci.

Kľúčové slová: Gestalt terapia. Usmernenie. Sociálna práca.

INTRODUCTION

The article briefly introduces the most important characteristics of Gestalt therapy and the principles on which Gestalt therapy is based. It will then discuss a study conducted with patients who have undergone breast cancer treatment and developed symptoms of post-COVID syndrome. The research has been conducted in Italy and in Poland in different centres that focus on helping women and their families who suffer from breast cancer and its consequences. The aim of the research is to find out what kind of support patients would need from social workers who act as Gestalt therapists. The research involves 200 women aged between 40 and 60. The research is based on a qualitative approach through semi-structured interviews.

Gestalt is a German term for which there is no exact scientific translation. It encompasses the higher-order patterns or signs that emerge when two or more perceptual elements are placed in close spatial or temporal proximity to each other, patterns that do not arise when only one element is present. The whole is perceived as its parts, and the human mind uses a "precognitive" process to literally see the forest for the trees. Thus, Gestalt theory emphasizes the need for people to recognize events as a whole or greater than the

sum of their parts. Gestalt therapy is an experiential form of psychotherapy that helps the client focus on the present and become aware of his or her psychological and physical needs in the present moment (Van Boven, Epley 2003). It was developed by Frederick (Fritz) and Laura Perls in the 1940s and emphasizes the client-therapist dialogue and relationship (Corey 2009). It is designed to be comprised of principles and elements from a variety of philosophies (Van Boven, Epley 2003). It represents an existential, phenomenological, and process-based approach developed on the premise that individuals must be understood in the context of their permanent relationship with their environment (Corey 2009). Its "key elements include phenomenological, experiential, humanistic, and existential approaches" (Corey 2009, p. 212). The phenomenological approach in Gestalt therapy focuses on clients' perceptions of reality. Phenomenology emphasizes whatever is happening now and does not focus on the past; however, the phenomenological approach motivates clients to look forward to real experiences that are yet to come (Brownell 2010). The experiential approach in Gestalt therapy emphasizes awareness and integration, which helps clients understand what and how they think, feel, and do. It takes into account a person's experience lived in the present moment, paying attention to the here and now and awareness of personal choice and responsibility (Raffagnino 2019).

APPROACHES IN GESTALT THERAPY

The humanistic aspect of Gestalt therapy focuses on gaining awareness of emotions and behaviours in the present rather than in the past. It emphasizes growth and acceptance and considers human nature to be essentially positive and fundamentally good (Corey 2009 Levine 2011). As an existential approach, Gestalt therapy is based on the belief that clients are “always in the process of becoming, remaking, and rediscovering” (Corey 2009 p. 212). Gestalt therapy emphasizes that clients have the capacity for self-awareness and choice. A central element of the Gestalt therapy approach is to help clients become aware of what they are doing and experiencing (Corey 2009; Oaklander 2001; Levine 2011; Wedding, Corsini 2013). The Gestalt therapy approach emphasizes the process of therapy more than its content (Corey 2009). Gestalt therapy is active and therapists are encouraged to direct clients toward experiences rather than just talking about circumstances (Corey 2009). The Gestalt therapy view of human nature is rooted in phenomenological, existential, and field theories (Brownell 2010; Oaklander 2001; Corey 2009). Gestalt therapy essentially believes that a person can deal with his or her problems if he or she becomes aware of what is going on inside and outside of him- or herself (Corey 2009; Oaklander 2001). Gestalt therapy assumes that the client has the capacity for self-regulation for growth and healing. It encourages clients to become strong enough to carry on and bear the weight of their own personal growth. Gestalt therapy theorizes that problems arise when a person tries to be somebody else. Gestalt therapy emphasizes that authentic change occurs when an individual becomes fully aware of who and what he or she is, as opposed to changing into who or what he or she is not. It is important for clients to “be as fully in their current state as possible, as opposed to trying to become what they ought to be” (Corey 2009, p. 212).

THE ROLE OF SOCIAL WORKERS AS GESTALT THERAPISTS

The goal of Gestalt therapy is to help clients gain awareness of how they operate or interact with family or friends in their own environment. Gestalt therapists see each person as a unified and coherent whole, and “the whole is distinct from the sum of its parts.” They are interested in the whole person and do not focus on one particular aspect of an individual. At the same time, they focus on clients' experience in terms of their thoughts, feelings, perceptions, behaviours, bodily sensations, memories, and dreams (Corey 2009). Gestalt therapy is rooted in field theory, which emphasizes that each organism is part of an ever-changing field and that each organism must be seen in its own environment or its context (Brownell 2010). Field theory is “a theory about the nature of reality and our relationship to reality.” (Corey 2009 p. 329). Thus, Gestalt therapists attempt to uncover what is happening

on the border between the client and the environment. Gestalt therapy believes that the client perceives those aspects of experience in which he or she is most interested. Other aspects of the experience provide only a background which is often outside the client's awareness. Gestalt therapy focuses on the way the client organizes experiences and interprets experiences from moment to moment. In this context, Gestalt therapists encourage clients to move toward problems and away from them. In addition, they believe that individuals are capable of self-regulation and are also motivated by self-discovery and discovery of their needs, feelings, and interests. What clients feel, observe, need, want, or believe is necessary for their self-regulation (Corey 2009). True growth begins with “conscious awareness of what is going on in one's present existence, including how one is affected and how one affects others” (Corey 2009 p. 329.). Therefore, Gestalt therapists help clients work toward awareness of their interests, needs, and their ability to regain a sense of balance in their lives. Gestalt therapy focuses on the here and now, the what and how, and the relationship between therapist and client (Corey 2009; Levine 2011). Gestalt therapists emphasize the present moment and believe that power is in the now. In most cases, clients focus on their past mistakes by thinking about how their lives could have been different or by focusing on making plans for their lives in the future. Reliving the past and worrying about the future diminishes the power of the present and interferes with an individual's ability to make authentic change and realize who they really are. In Gestalt therapy there is only the present because the past is gone and the future has not yet arrived. (Corey 2009). Clients discuss their feelings as if they are disconnected from their present experience and have difficulty experiencing their feelings in the here and now. Therapists who practice Gestalt therapy therefore help clients become aware of their present experience. Gestalt therapists ask “what” and “how” questions instead of “why” questions to help clients connect with the present. Questions like “what is happening right now?” and “what are you experiencing as you are sitting there” are used to promote clients' awareness of the present. Rather than neglecting or disrespecting clients' pasts, they acknowledge the past as an important influence that shapes clients' current attitudes and behaviours. They also encourage dialogue in the present by asking clients to bring the past into the present moment by bringing it forward as if they were living it in the here and now (Corey 2009). One important element in Gestalt therapy is unexpressed feelings, including resentment, anger, hatred, pain, anxiety, sadness, guilt, and abandonment. These feelings are not fully experienced; they are in the clients' unconscious. They remain in the background and are carried into their present life in ways that interfere with their successful contact with other people. This unfinished business stays with the client until he or she deals with the unexpressed feelings and removes some blockages that they also have on the physical level. The holistic approach towards the mind and the body present in Gestalt therapies

stems from the attention to the body, body language processes and body awareness (Corey 2009). Therefore, in the context of unexpressed feelings, Gestalt therapists emphasize the bodily experience. They build upon the assumption that “if feelings are not expressed they tend to lead to physical sensations or problems.” (Corey 2009 p. 216.). When clients find themselves in a difficult situation in which it seems impossible to make any progress, or if there is no external support available to them, they reach an impasse. During this phase, the client is unable to engage in new constructive behaviours or move forward despite fear or panic. Gestalt therapists help clients in this instance by providing an environment that encourages them to fully experience their state in this impasse. As a result, clients are able to connect to their frustrations, acknowledge unfinished feelings instead of wishing they were different, and begin to think, feel, and act differently (Corey 2009). This new state helps them experience growth and actualization. Another concept emphasized in Gestalt therapy is contact, which means “being in touch with what is happening here and now, moment to moment.” (Corey 2009 p. 330). Change and growth do not exist without contact, which is made through seeing, hearing, smelling, touching, and moving. Gestalt therapists address interruptions, disturbances, and resistance to contact, which work as coping mechanisms, but often prevent individuals from fully experiencing the present moment. Resistance is defined as ‘an unpleasant but fundamentally important manifestation of the integrity of the organism’. Resistance is an unconscious conflict within an individual that can develop from dysfunctional behaviour. Furthermore, resistance is a process of opposing “the formation of a figure (thought, feeling, impulse, or need) that threatens to emerge in a context that is considered dangerous” (Corey 2009 p. 342). To summarize the role of therapists in Gestalt therapy, the emphasis is placed on self-awareness and the quality of contact between the self and the environment. The main goal is to help clients become aware of what they are experiencing and how they are experiencing it. Gestalt therapists use active methods to help clients develop awareness, freedom, and self-regulation, rather than directing them toward predetermined goals. They actively and personally engage with clients and encourage them to pay attention to their sensory awareness in the present moment. They also act as guides and catalysts by presenting experiments and sharing observations. They do not impose change on clients through confrontation (Corey 2009). They focus on the processes of awareness and contact with clients and their body language. The latter provides them with information about clients' hidden feelings. They also focus on conveying important messages about clients' feelings, which are linked to behaviour and internal meanings, through non-verbal language, including movements, postures and gestures. At the same time, in terms of theory and the research conducted, it should be noted that the techniques are clearly defined and have received some empirical validation for their relevance (Wagner-Moore 2004).

GESTALT THERAPY'S CONTRIBUTION TO SOCIAL WORK GUIDANCE

Since January 2022, research has been conducted with patients who have developed symptoms of post-COVID syndrome after breast cancer treatment. The research is being conducted in Italy and in Poland in different centres that focus on helping women and their families who suffer from breast cancer and its consequences. The aim of the research is to find out what kind of support patients would need from social workers who act as Gestalt therapists. The research involves 200 women aged between 40 and 60. The research is based on a qualitative approach through semi-structured interviews.

The research results have shown thus far that breast cancer patients who develop symptoms of post-COVID syndrome after treatment seek honesty, authenticity, reciprocity, tolerance, a non-judgmental approach, assertion of responsibility and empowerment in their relationships with social workers. According to the respondents, human, sincere and equal relationships, as well as acceptance and understanding, help to gain their trust and thus create conditions for change. These relationships, according to the respondents' statements, foster awareness and responsibility in them.

Patients have also said that they would need guidance from social workers during and after treatment through Gestalt therapy, as Gestalt therapy sees both “growth” and “development” as key components of a person's motivation in life, as well as the belief that all individuals are born with an intrinsic sense of motivation and the ability to self-interact. Patients have liked Gestalt therapy's emphasis on satisfaction and attachment, the belief that the self cannot exist without the influence of other people, and that the organizational structure and content in the mind are formed primarily through interactions of the self with others. In addition, it seeks to help the individual explore his or her consciousness and understanding. In other words, in Gestalt therapy, the client and the counsellor can experiment with using different ways of thinking and acting to better understand the experiences of the “victim” in life situations.

In Gestalt therapy, great emphasis is placed on the individual and his or her responsibility for his or her own existence. The interviewed patients said that they would need the social worker as a guide to support them in being “who they are” and “where they are”.

Patients have also reported that Gestalt therapy helps to alleviate some of the symptoms of post-COVID syndrome, such as moodiness, depression, nervousness, enhanced stress reactions or sleep problems. Different exercises with a social worker as a therapist accompanying them through Gestalt therapy help to induce a feeling of physical and psychological relaxation, which also improves patients' sleep patterns.

The results of the research thus far have also shown that the knowledge and skills of Gestalt therapy are very useful for the field of social work. According to the respondents, it helps them to process strong or negative emotions, to go “deeper” in interpersonal relationships, and to not limit themselves to formal, superficial communication. They also help to strengthen the ability to actively listen by creating a safe environment in which respondents can find support, genuine interest, space for self-discovery and engagement.

CONCLUSION

For the purpose of conducting similar research, it is important to promote and develop a pro-client-oriented model of guidance in social work based on humanistic and existential values, and the therapeutic aspects of social work. With this intention in mind, it is necessary to adjust accordingly the training programmes designed for social workers in cooperation with experts working in the field of Gestalt therapy. One of the tools for the implementation of such a model could be the application of Gestalt therapy principles to the practice of guidance in social work.

Conflicts of interests

The author declare no conflict of interests.

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REFERENCES

1. Brownell, P (2010). *Gestalt therapy: A guide to contemporary practice*. Springer Publishing Co. 2010.
2. Corey, G. (2009). *Theory and practice of counseling and psychotherapy*. Australia; Belmont, CA, Thomson/Brooks/Cole. 2009.
3. Levine, T. B. Y. (2011). *Gestalt therapy: Advances in theory and practice*. London: Routledge, 2011
4. Oaklander, V. (2001). Gestalt play therapy. *International Journal of Play Therapy* 2001; 10(2): 45 — 55. <https://doi.org/10.1037/h0089479>
5. Raffagnino, R (2019). Gestalt Therapy Effectiveness: A Systematic Review of Empirical Evidence. *Open Journal of Social Sciences*. 2019; 07(06): DOI 10.4236/jss.2019.76005
6. Van Boven, L, Epley, N (2003). The unpacking effect in evaluative judgments: When the whole is less than the sum of its parts. *Journal of Experimental Social Psychology* (2003); 39(3): 263 — 269. [https://doi.org/10.1016/S0022-1031\(02\)00516-4](https://doi.org/10.1016/S0022-1031(02)00516-4)
7. Wagner-Moore (2004). Gestalt therapy: past, present, theory and research. *Psychotherapy: Theory, Research, Practice, Training* (2004); 41 (2): 180 — 189. DOI 10.1037/0033-3204.41.2180
8. Wedding D, Corsini R J (2013). *Current Psychotherapies*. Boston, MA: Cengage Learning. 2013.

Breast self-examination as part of breast cancer early diagnosis

Samovyšetovanie prsníkov v rámci včasnej diagnostiky karcinómu prsníka

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ABSTRACT

Introduction: Palpable findings in women of various age categories, generally called “lumps”, include up to 80 % of benign (non-malignant) breast diseases. Some represent “only” changes in the structure of the gland, e.g. on the basis of diffuse or focal hormonal changes, others belong to typical solid or cystic diseases (fibroadenoma, cyst, adenoma, papillomas, etc.) with typical and less typical clinical findings. Differential diagnosis, diagnosis, management, and treatment are not always simple.

Objective: The aim of the work is to verify the benefit of breast self-examination in the population of women up to 45 years of age, the importance of sonography and its place from the point of view of further monitoring of the patient, taking a biopsy and/or indicating a surgical solution.

Material and methods: In the retrospective study, we included 97 patients with histologically verified findings of breast cancer in the period January 2017-January 2020. We monitored the age of the women and, in the case of examination, also the palpability of the lesion, the result of the biopsy examination, the grading of intraductal carcinoma, the proliferation index, the presence of HER2, BRCA, family history and lesion size.

Results: We divided the patients into 5 groups according to age. We tested the differences between the five groups in the parameters of the proliferation index and the size of the lesions. The lesion must probably reach a certain size for the patient to feel it and seek help. In women under 40 years of age, we did not demonstrate a significant effect of age on the occurrence, grading, histological type, and size of breast tumor lesions.

Conclusion: From our results, it appears that all diagnosed carcinomas were within the limits of palpable lesions in size, so that during self-examination or preventive examinations of young women, the lesions are palpable. This clearly testifies to the high benefit of properly implemented breast self-examination and significantly reduces the legitimacy of screening for breast cancer in women under the age of 45 using sonography.

Keywords: breast self-examination, prevention, screening, sonography, mammography, biopsy, core cut biopsy

Úvod: Medzi hmatné nálezy u žien rôznych vekových kategórií, všeobecne nazývané ako „hrčky“ patrí až 80 % benígnych (nezhubných) ochorení prsníka. Niektoré predstavujú „len“ zmeny štruktúry žľazy napr. na podklade difúzných či ložiskových hormonálnych zmien, iné patria medzi typické solídne alebo cystické ochorenia (fibroadenóm, cysta, adenóm, papilómy a pod.) s typickými a menej typickými klinickými nálezmi. Diferenciálna diagnostika, diagnostika, manažment a liečba nebývajú jednoduché.

Cieľ: Cieľom práce je overiť prínos samovyšetovania prsníkov v populácii žien do 45 roku života, význam sonografie a jej miesto z pohľadu ďalšieho sledovania pacientky, odberu biopsie a/alebo indikácie chirurgického riešenia.

Materiál a metódy: Do retrospektívnej štúdie sme zahrnuli 97 pacientiek s histologicky verifikovanými nálezmi karcinómov prsníka v období január 2017-január 2020. Sledovali sme vek žien a v prípade vyšetrenia aj hmatnosť ložiska, výsledok bioptického vyšetrenia, grading intraduktálneho karcinómu, proliferatívny index, prítomnosť HER2, BRCA, rodinnú anamnézu a veľkosť ložiska.

Výsledky: Pacientky sme podľa veku rozdelili do 5-tich skupín, Testovali sme rozdiely medzi piatimi súbormi v parametroch proliferatívneho indexu a veľkosti lézií, Rozdiely medzi súbormi vo veľkosti útvarov — medzi skupinami nevyplývajú žiadne náznaky diferenciácie veľkosti lézií medzi jednotlivými kategóriami žien. Lézia musí zrejme dosiahnuť určitú veľkosť, aby si ju pacientka nahmatala a vyhľadala pomoc. U žien mladších ako 40 rokov sme nepreukázali významnejší vplyv veku na výskyt, grading, histologický typ a veľkosť lézie nádorov prsníka.

Záver: Z našich výsledkov sa javí, že všetky diagnostikované karcinómy boli veľkostne v hranici hmataných lézií, takže pri samovyšetrení alebo preventívnych prehliadkach mladých žien sú ložiská hmatné. To jednoznačne svedčí pre vysoký prínos správne realizovaného samovyšetovania prsníkov a výrazne znižuje oprávnenosť skríningu karcinómu prsníka u žien do 45.-teho roku života pomocou sonografie.

Kľúčové slová: samovyšetovanie prsníkov, prevencia, skrínig, sonografia, mamografia, biopsia, core-cut biopsia

INTRODUCTION

Statistically, up to 80 % of the most common palpable findings in the breasts in the age category of women under 40 are benign (non-malignant) changes. The group of benign changes is quite broad, the clinical and morphological characteristics as well as the findings of imaging methods are often diverse and not always unambiguous. We most often encounter clinical names: mastopathy, fibrocystic breast disease, microcystosis... These terms belong to clinical fields: mammology in gynecology, gynecology, surgery, onco-surgery, clinical oncology, endocrinology and histopathology. The fact that it is not cancer applies to all these diseases, i.e. malignant disease of the breast. Benign breast diseases are often clinically symptomatic. They are manifested by diffuse or local symptoms — pain (mastodynia) — lumps, nodularization, bilateral or localized findings in individual quadrants, linked to hormonal activity, cyclic in nature, during ovulation or premenstrual. These diseases occur most often in the young female population (Strnad, Daneš 2001, Daneš 2021). When a benign disease is suspected, sonography (ultrasound, ultrasonography) is the method of first choice in the group of women up to the age of 35. Self-examination is generally recommended for women. These examinations are the subject of practical training and are of great importance in the early prevention

of breast cancer. In young women, an objective imaging method is sonography. It is an examination without the risk of ionizing radiation. Young women mostly have breasts very rich in fibroglandular tissue with a small admixture of fat. If we use sonographic direct and indirect criteria of benign and malignant lesions during the sonographic examination, we are really able to differentiate between cystic and solid deposits and also determine the suspicion of benign or malignant disease. We use the BI-RADS (Breast Imaging Reporting and Data system) scale developed by the American Radiological Society to evaluate mammographic, sonographic, magnetic resonance and histological findings in the breasts. (Burnside, Sickles 2009) In the case of suspicion of cancer, which is really not an exception even at a younger age, i.e. when using the BI-RADS 4a, b., c and/or BI-RADS 5 scale, we indicate histological verification of the deposit to resolve the finding. According to EUSOBI criteria and recommendations (European society of breast imaging, Sardanelli et al. 2019), it is a sonographically controlled core-cut biopsy or vacuum mammotomy. They are the most progressive forms of core biopsy, vacuum mammotomy is already a form of small surgical procedure of sample collection and replaces the so-called open minimal surgical biopsy — excision (Enion, Dixon 2008, Daneš 2021). The most common solid finding in younger women is hormonally active-dependent areas of the gland, or fibroadenomas (Heywang-Kobrunne,

Dershaw 1997). However, the risk of breast cancer from a fibroadenoma is no higher than the general risk of breast cancer in the normal population.

Excision is primarily indicated for those types of fibroadenomas that have stromal remodeling, higher cellularity and are difficult to differentiate from phyllodes tumor in core-cut biopsy or fine-needle biopsy findings. Surgical treatment is also indicated for most of the so-called juvenile fibroadenomas (Apple, Dascalos, Basset 2011, Pasqualini, Corets-Prieto et al, 1997). Benign breast lesions include a large number of other pathological entities, such as intraductal papilloma, galactocele, phyllodes tumor, adenoma, lipoma, hamartoma, tubular and lactating adenoma, pseudoangiomatous stromal hyperplasia, breast infarction, radial scar (image of radial — internal parenchymatous scar), infections, inflammatory diseases, edematous changes, which include, for example, allergic reactions, lymphedema of non-malignant origin, diabetic mastopathy, trauma and injuries, post-traumatic conditions, the most common of which are hematomas, fat necrosis and oil cysts, as well as keloid scars, skin affections. Benign and frequent changes include intramammary lymph nodes and skin lesions.

In young women, the incidence of breast cancer is lower compared to women over 45 and 50 years of age. In 2008, 2,608 new breast cancers were diagnosed in Slovakia, in 2003 only 2,016 cases, in 1983 1,002 cases and compared to 1968, when the number of newly diagnosed breast cancers in women was 821, this is an increase of more than 200 % of new cases over a period of 45 years (Lehmann et al. 2012). This increase is clearly significant. Up to 6—8 % of newly diagnosed cases of breast cancer are diagnosed worldwide in young women under the age of 40 (Ries 2013). The prognosis of this serious disease depends on several factors, one of the main risk factors is the age of the patient, then the stage of the disease, histological diagnosis — grading and results of immunohistochemical laboratory tests, genetic status and the presence of other risk factors. For patients from the age of 40, the preventive examination is a mammogram and subsequent modalities are sonography, biopsy and, if necessary, magnetic resonance. In young asymptomatic women (between the ages of 20 and 40), sonography is the first diagnostic modality (Kheirleisid, Boggs, Curran et al.: 2011). According to the wording of Annex no. 2 of the Act on the Scope of Health Care Reimbursement No. 577/ 2004 Coll. (577/2004 Coll. — Act on the scope of health care) asymptomatic women from the age of 18 are indicated as part of a preventive gynecological examination, a clinical palpation examination once a year and a sonographic preventive breast examination at an interval of once every two years.

OBJECTIVE

The aim of the work is to verify the benefit of self-examination and palpation examination in young women with detec-

ted malignant lesions in a retrospective study from the period of 3 years of work at the mammological clinic Rádiologické klinika s. r. o. in Trenčín. From the captured and histologically verified malignant lesions in the set of diagnosed malignant foci, we compare the results of the palpation examination, sonography and biopsy with the final histopathological findings.

MATERIAL AND METHODS

During the study period, a total of 97 women were diagnosed at our department. Within the mammographic examination, ultrasound (USG — B-K 400, Siemens SG 50), mammography (MG — Nova 3 000 Siemens, FUJI Amulet) and (MR — 1,5 T Siemens) were applied. Biopsies were performed by the “freehand” method, under the control of sonography, core-cut 16 and 14 G, core 15 and 22 mm., or fine-needle biopsy, needle 20 G. The age of the women and, in the case of the examination, the palpability of the lesion, the result of the biopsy, the grading of the intraductal carcinoma, the proliferation index, the presence of HER2, BRCA, the family history and the size of the lesion were observed.

Patients were divided into five groups according to age. Group A consisted of women aged less than 30 years (n = 6), group B consisted of women aged 31—35 years (n = 8), group C consisted of women aged 36—40 years (n = 28), group D consisted of women aged 41—45 years (n = 32), and the last group E consisted of patients aged 46—50 years (n = 23).

The non-parametric Kruskal-Wallis test was used to compare the numerical data. In case of dependence between the different parameters studied, we used the nonparametric Spearman correlation coefficient. We processed the abundances of nominal data in each category with contingency tables using chi-square test. If the p-value of the test criterion of statistical tests was less than the number 0.05, we considered the differences between the observed variables as non-random and due to the influence of the observed factors.

RESULTS AND DISCUSSION

In the aspect of the results presented in the tables of the results section, it is important to state that not all patients from the mentioned set had all examinations performed. For this reason, the numerical values of the results of individual categories may be lower than the initial number of patients in the given group. A basic overview of the performed examinations in the entire set is presented in Table 1.

In the first step, we tested the differences between the five sets in the parameters of proliferation index and lesion size. The results of proliferative index testing are shown in Table 2.

An interesting finding emerges from the results presented in Table 2.

Although the result of the non-parametric test did not reach the formal limit of the numerical p-value of 0.05, which is necessary to reject the assumption of agreement between individual age subgroups, it is relatively close to this value ($p = 0.07$). If we would achieve e.g. a result with a p-value of the test criterion $p = 0.70$, it would testify clearly in favor of mutual agreement of the sets in the size of the proliferation index.

Table 1: Overview of examined parameters

age	n	USG	MG	MR	L	Bio	Bio-	Bio+	IDC	prolif	Her	RA	BRCA	Velk
To 30	6	6	1	5	5	6	I II III IV	I 5 II 1 III IV V	I II 3 III 2 IV	6	+1/6 x	I II 1/6 x	+1 X5	6
31–35	8	8	6	5	6	8	I II III IV	I 5 II 2 III 1 IV V	I 1 II III 4 IV	8	+2/6 x 2	I II 1/6 X2	+ X1	8
36–40	28	28	24	20	19	25	I II 1 III IV 2	I 2 II 1 III 11 IV V 1	I 3 II 2 III 5 IV	17	+2/22 X6	I- II 8/24 X4	+2/9 X19	25
41–45	32	32	32	19	19	32	I II III IV	I 14 II 4 III 12 IV 2 V	I 4 II 3 III 6 IV 1	29	+5/30 X2	I 1/31 II 6/31 X1	+2/7 x	32
46–50	23	23	23	16	14	23	I II III IV	I 13 II 5 III 4 IV 1 V	I 3 II 3 III 6 IV 1	23	+7/23 x	I 4/23 II 7/23 x	+2/13 x	23

Legend: n-total number of women in the age group, USG-number of women examined by ultrasound, MG-number of women examined by MG, MR — number of women examined by MR, L-number of women with a palpable lesion, Bio- number of women with a positive biopsy, Bio- negative biopsy finding (/1 = fibroadenoma 2 = adenosis 3 = ADH 4 = Phyllodes tumor/ — only in the third age group of women in three women), Bio type in case of a positive biopsy finding (1 = IDC, 2 = ILC, 3 = DCIS, 4 = mucinous 5 = gelatinous), IDC — grade (1 = IDC I 2 = IDC II 3 = IDC III 4 = triple negative), prolif — number of women in whom the proliferation index was determined, HER — number of positive findings, RA — all findings, where x = unexamined, BRCA — number of positive/out of all plus x-unexamined, size — number of women with specified lesion siz

Table 2: Testing of differences in proliferative index between sets.

Age group	n	\bar{x}	sd	xm	min.	max.	p
to 30 years.	6	28,3	19,4	25	10	60	0,07
31 — 35 years	8	44,4	21,9	50	5	70	
36 — 40 years.	17*	22,6	24,0	10	5	80	
41 — 45 years.	29	19,3	20,4	10	5	80	
46 — 50 years	23	24,8	23,3	15	5	70	

Legend: n — number of patients, \bar{X} — arithmetic mean, sd — standard deviation, xm — median, min. — minimum value, max. — maximum value, p — value of the test criterion of the Kruskal-Wallis test, * there were 28 women in the set, but the proliferation index was determined only in 17 women

Table 3: Testing for differences in lesion size in different age groups of women.

Age groups	<i>n</i>	\bar{x}	<i>sd</i>	<i>xm</i>	<i>min.</i>	<i>max.</i>	<i>p</i>
to 30	6	2,5	1,1	2,5	1	4	0,70
31 — 35	8	2,4	0,7	2,0	2	4	
36 — 40	25	2,6	1,1	2,0	1	5	
41 — 45	32	2,7	1,0	2,5	1	5	
46 — 50	23	2,4	0,7	2,0	2	4	

Legend: *n* — number of patients, \bar{x} — arithmetic mean, *sd* — standard deviation, *xm* — median, *min* — minimum value, *max* — maximum value, *p*- value of Kruskal-Wallis test criterion

Table 4: Testing the positivity of biopsy

The parameters	IDC	ILC	DCIS+muc*	total
Age up to 40 years	22	4	12	38
Age over to 40 years	27	9	19	55
total	49	13	34	93

Legend: chi-square test, $p = 0.82$; $df = 2$; *only one case was gelatinous — not included in the calculations

In this case, however, the *p*-value of the test criterion is located in the zone of the so-called marginal level of significance ($0.05 < p < 0.10$) in which we can no longer afford such a simple conclusion. Looking at the center indicators (arithmetic mean and median) in Table 2, we can see that they have higher values in the first two age categories than in the remaining three. In other words, it seems to us that in the age categories up to 35 years the proliferation index was slightly higher than in older age groups. However, the statistical test used did not evaluate this fact as statistically significant, apparently due to the lower number of patients in the mentioned first two groups ($n = 6$; respectively $n = 8$; table 2). It can be assumed that if the proliferation index is really higher in a younger organism, then with an increase in the number of examined patients in these age groups we will really be able to expect statistically significant differences compared to older age groups. It should be emphasized that even though we used the term “lower number of patients“, given the requirements of the non-parametric Kruskal-Wallis test for the minimum number of samples ($n > 5$), we fulfilled the condition for its use.

Subsequently, we tested for differences between sets in the size of the formations. The results are presented in Table 3. Table 3 shows no indication of differentiation in lesion size between the different categories of women. In this case, however, it has nothing to do with biometabolic processes in neoplastic transformation, but apparently only a natural consequence of seeking medical help when a palpable formation is found. Apparently, the lesion must reach a certain size for the patient to palpate it and seek help, but there has never been a situation in which patients have underestimated the discovery of an

anomaly for some reason and sought medical help only later when the size of the lesion was larger.

Subsequently, we tested the representation of each category of histological findings of the biopsy specimen with respect to the age groups of the patients. The results are shown in Table 4. In this case, we had to merge not only the age categories of the patients, but also the categories of histological findings in the biopsy material. Table 4 clearly shows that the type of finding is in no way related to the age category of the patients.

In the overall summary of our results presented in individual tables, we can state that the most common solid findings in younger women are hormonally active-dependent areas of the gland, or fibroadenomas, while these tend to be palpable and are the most common cause of sonographic examination of women with palpable findings, which is in accordance with data published so far (Heywang-Kobrunne, Dershaw 1997). However, the risk of breast cancer from a fibroadenoma is not higher than the general risk of breast cancer in the normal population. Our data clearly show that despite the increase in absolute numbers of newly diagnosed cancers in young women, their increase is not higher than in women from other age groups (Slobodníková, Krajčovičová, Meluš 2015). We conclude that sonography is not a method of screening and prevention in young women without tangible findings, where it does not bring the desired effect and only increases the number of diagnosed cysts, cystoid benign lesions, areas of the gland with hormonal changes, and the number of fibroadenomas (Kopans, 2016). All cancers found in a retrospective study from the mammography department

of Rádiologické kliniky s. r. o. in Trenčín in women up to 40 years of age were clinically palpable, therefore we conclude that self-examination is irreplaceable and of key importance in this age group (Skovajsová 2015), in accordance with published data.

CONCLUSION

In women younger than 40 years, we did not demonstrate a significant effect of age on the occurrence, grading, histological type and size of breast tumor lesions. On the contrary, it appears from our results that all diagnosed carcinomas were within the range of palpable lesions, so during self-examination and preventive examinations of young women, the lesions are palpable. Preventive sonographic examinations in women with non-palpable findings are not justified. With the huge number of sonographic preventive examinations of women under the age of 40, diagnostic offices could pay more attention to the screening of women over the age of 45, which is not carried out to the required extent in Slovakia (also due to lack of funds).

Conflicts of interest

The authors declare no conflicts of interest.

REFERENCES

1. 577/2004 Z. z. — Zákon o rozsahu zdravotnej starostlivosti uhrádzanej na základe verejného zdravotného poistenia a o úhradách za služby súvisiace s poskytovaním zdravotnej starostlivosti, Príloha č. 2
2. Apple S. K., Doepke L., Bassett L. W.: Benign cystic Lesions of the Breast, in: Breast Imaging, Elsevier, 2011, ISBN: 978-1-4160-5199-2, str. 239 — 254
3. Apple S. K., Dascalos J. M., Bassett L. W.: Solid Benign Lesions of the Breast, in: Breast Imaging, Elsevier, 2011, ISBN: 978-1-4160-5199-2, str. 255 — 260
4. Assi Ha et al.: Epidemiology and prognosis of breast cancer in young women, in: J Thorac Dis. 2013 Jun; 5 (Suppl 1): S2-8. doi: 10.3978/j.issn.2072-1439.2013.05.24.
5. Burnside E., Sickles EA et al: The ACR BI-RADS experience: learning from history: J. Am. Coll. Radiol., 2009, 6, 851 — 860
6. Daneš J. a kol.: Screening a diagnostika karcinomu prsu, Grada, Grada Publishing, 2021, ISBN 978-80-271-1239-5, 206 str.
7. Enion D. S., Dixon A. M.: Benign breast disease, in: Breast ultrasound, Elsevier, 2008, ISBN-13: 978044310076 5, str. 139 — 162
8. Guray M., Sahin A. A.: Benign breast diseases: classification, diagnosis and management, Oncologist, 2006, 11: 435 — 49
9. Heywang-Kobrunne S. H., Dershaw D. D.: Diagnostic Breast Imaging, 1997, GeorgThieme, ISBN 3-13-102891-2, 400 str.
10. Kheirelseid E. H., Boggs J. M., Curran C et al.: (2011) Younger age as a prognostic indicator in breast cancer: a cohort study. BMC Cancer 11: 383 — 389
11. Kopans, D. B.: It's time to stop the misinformation about breast cancer screening, in: Screening and Beyond, m ESR. EUSOBI, 2016, ISBN 978-3.9504388-3-3, 188 pp
12. Lehman C. D., Lee C. I., Loving V. A., Portillo M. S., Peacock S., Demartini W. B.: Accuracy and value of breast ultrasound for primary imaging evaluation of symptomatic women 30-39 years of age. AJR Am J Roentgenol, 2012, 199: 1 169 — 1 177
13. Pasqualini J. R., Corets-Prieto J. et al: Concentration of estrone, estradiol and their sulfates and evolution of sulfatase and aromatase activities in patients with breast fibroadenoma. Int. J. Cancer, 70, 1997, 6, s. 639 — 643
14. Ries A., Eisner M., Kosary C. et al: SEER Cancer Statistics Review, 1975 — 2002, Bethesda, MD: National Cancer Institute. http://seer.cancer.gov/csr/1975_2002/, based on November 2004 SEER data submission, posted to the SEER web site 2005 (accessed 5 March 2013)
15. Sardanelli et al. Position paper on screening for breast cancer by the European Society of Breast Imaging (EUSOBI) and 30 national breast radiology bodies from Austria, Belgium, Bosnia and Herzegovina, Bulgaria, Croatia, Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Iceland, Ireland, Italy, Israel, Lithuania, Moldova, The Netherlands, Norway, Poland, Portugal, Romania, Serbia, Slovakia, Spain, Sweden, Switzerland and Turkey, Eur Radiol. 2017; 27(7): 2 737 — 2 743, ISBN 978-3-662-37346-0
16. Skovajsová M.: Řeším svou bulku v prsu, Nadace Vize, Alaiince žien s rakovinou prsu, Praha 2015
17. Slobodníková J., Krajčovičová Z., Meluš V.: Karcinóm prsníka mladých žien — retrospektívna štúdia z pracoviska rádiologickej kliniky s. r. o. 2015. In: Zdravotnícke listy. — ISSN 1339-3022. Roč. 3, č. 1(2015), s. 19 — 26
18. Strnad P., Daneš J.: Nemoci prsu pro gynekology, Grada Publishing, 2001, ISBN 80-7169-714-1, 324 str.

Labratory diagnosis of tuberculosis – overview

Laboratórna diagnostika tuberkulózy – prehľad

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ABSTRACT

Introduction: Tuberculosis is a global public health problem in terms of the highest reported mortality of all emerging infections.

Objective: This work can serve as an overview of the used diagnostic methods and susceptibility testing or resistance to anti TB drugs.

Core of work: The diagnostic procedure for tuberculosis is based on a thorough anamnesis, assessment of the epidemiological situation, clinical examination, imaging methods (anteroposterior X-ray or CT scan), microbiological examinations, endoscopic examination (bronchoscopy), histological examination, tuberculin sensitivity and detection of latent TB infection.

Conclusions: The diagnosis of this disease in several endemic areas of TB around the world is currently a problem. Therefore, better diagnostic techniques have recently been developed in an effort to achieve a more accurate result. Elimination of the disease is still hampered by high rates of multidrug-resistant TB and by the spread of TB in vulnerable groups of the population

Keywords: tuberculosis, diagnosis, anti TB drug resistance tests

ABSTRAKT

Úvod: Tuberkulóza je globálnym problémom verejného zdravia z hľadiska najvyššej hlásenej úmrtnosti zo všetkých vznikajúcich infekcií.

Zameranie: Táto práca môže slúžiť ako prehľad používaných diagnostických metód a testov citlivosti alebo rezistencie na antituberkulotiká.

Jadro práce: Diagnostický postup pri tuberkulóze je založený na dôkladnej anamnéze, zhodnotení epidemiologickej situácie, klinickom vyšetrení, zobrazovacích metódach (predozadný RTG alebo CT), mikrobiologických vyšetreniach, endoskopickom vyšetrení (bronchoskopia), histologickom vyšetrení, tuberkulíne citlivosť a detekciu latentnej infekcie TBC.

Záver: Diagnostika tohto ochorenia vo viacerých endemických oblastiach TBC na celom svete je v súčasnosti problémom. Preto sa v poslednej dobe vyvinuli lepšie diagnostické techniky v snahe dosiahnuť presnejší výsledok. Eliminácii ochorenia stále bráni vysoká miera multirezistentnej TBC a šírenie TBC u zraniteľných skupín obyvateľstva

Kľúčové slová: tuberkulóza, diagnóza, testy rezistencie na lieky proti TBC

INTRODUCTION

The individual diagnostic procedures are linked to each other according to the basic results. A patient who has come into occasional or repeated contact with a source of infection, or a patient whose clinical picture is suspicious of specific pulmonary changes, requires a comprehensive specialist examination. The diagnostic procedure for tuberculosis is based on a thorough anamnesis, assessment of the epidemiological situation, clinical examination, imaging methods (anteroposterior X-ray or CT scan), microbiological examinations, endoscopic examination (bronchoscopy), histological examination, tuberculin sensitivity and detection of latent TB infection.

DIAGNOSIS OF ACTIVE AND LATENT TUBERCULOSIS

Active tuberculosis can be diagnosed by isolating bacilli (derived from the *Mycobacterium tuberculosis* complex) from body secretions. In the pulmonary form of tuberculosis, a chest X-ray as well as sputum examination are included in the initial testing. Sputum evaluation includes Acid-Fast Bacilli smear (AFB smear), nucleic acid amplification test (NAAT) as well as mycobacterial culture. Inability to produce sputum can sometimes be a problem; in this case, we can use nebulized hypertonic saline to induce sputum (Jilani et al. 2021).

To assess the risk of active TB as well as to enable prompt preventive treatment, it is crucial to have an early diagnosis of latent tuberculosis infection (LTBI) after documented or suspected exposure. Therefore, in order to eliminate TB, in low-incidence countries it is necessary to detect groups at higher risk of TB at both community and occupational levels. Diagnosis of latent tuberculosis (which is indirect) relies on the detection of an immune system response against *Mycobacterium tuberculosis* antigens, assuming that an immune response has been developed after the contact with the pathogen. The main diagnostic tests for LTBI are the interferon gamma release assay (IGRA) and the tuberculin skin test (TST). These are indirect tests that are based on the immune response to TB and do not directly assess the viability or presence of TB bacilli. In addition, no test is currently available that can distinguish the response induced by active TB from the immune response caused by LTBI. Thus, the distinction between active TB and LTBI is based on clinical, radiological or bacteriological findings (Zellweger et al. 2020).

IMAGING METHODS

X-ray examination represents one of the most essential criteria to diagnose tuberculosis disease. WHO recommends that tuberculosis in children should be diagnosed on the basis of chest X-ray examination and contact tracing, even in case of the absence of a positive tuberculin skin test result. Since

chest radiographs have a sensitivity of only 40 %, they are not a good indicator of tuberculosis in children. This may have negative consequences for children with a confirmed anamnesis of a contact with tuberculosis, because a normal chest X-ray finding may lead to a misdiagnosis of LTBI instead of pulmonary tuberculosis, and thus to treatment only with isoniazid instead of a complete 4-drug regimen. In children whose chest X-ray examination results are inconclusive, computed tomography (CT) can detect changes and is superior to conventional chest radiography. CT scans are much more sensitive than conventional chest X-rays for detecting cavitations (which can occur in children). CT is also a good choice for detecting peripheral and mediastinal lymph nodes (very common in childhood tuberculosis). In 60 % of patients with tuberculosis, CT shows enlarged lymph nodes, whilst chest radiographs show nothing unusual. CT scans, which are characterized by high resolution, can reveal besides mediastinal abnormalities also findings in the lung parenchyma — such as centrilobular and miliary nodules (on conventional chest radiographs) (Santos et al. 2019).

MICROSCOPIC EVALUATION

In developing countries, sputum smear microscopy using Ziehl-Neelsen (ZN) staining is widely used for routine diagnosis of tuberculosis. This is because of its high specificity as well as cost-effectiveness, nor does it require any sophisticated equipment. Although smear microscopy results can be obtained within 2 hours, smear microscopy is characterized by lower sensitivity. This is due to the need for 5 000 — 10 000 bacilli per ml of sputum to subsequently demonstrate a positive result. Nearly 13 % of TB transmission occurs in patients with both TB and culture-negative sputum. Therefore, healthy individuals are at risk of *Mycobacterium tuberculosis* infection (leading to active TB development) if they come into close contact with TB suspects (with TB negative sputum). To increase the sensitivity of this test, a 3-day early morning sputum collection protocol is required. An AFB smear, which is also characterized by its technical simplicity, can be performed within a few hours, but on the other hand, it fails to distinguish nontuberculous mycobacteria from *Mycobacterium tuberculosis*. The other benefits of the above mentioned sputum microscopy are the assessment of a response to treatment as well as cure or treatment failure at the end of therapy (Rasool et al. 2019; Jilani et al. 2021).

Mostly depending on the methodology with which samples are collected, made, and then the already stained smears are examined, the sensitivity of sputum smear microscopy by the ZN method is reported to be variable or low (ranging from 20 % to 80 %). Therefore, if this procedure is used as the sole means of diagnosis, a significant number of cases remain undetected. For better results of sputum smear microscopy, fluorescence microscopy (FM) diagnosis has therefore been introduced. Compared to ZN method, the sensitivity of conventional FM

provides a much better yield as well as detection of positive smears. It is also less demanding to perform, i.e. it takes less time. Because of a possibility of false positive results caused by the incorporation of fluorochrome dyes by inorganic objects, there are doubts about the specificity of FM. A limitation of FM, especially in low to medium income countries, is its considerable cost (Dzodanu et al., 2019).

MYCOBACTERIAL SPUTUM CULTURE AND DRUG SUSCEPTIBILITY TESTING

Culturing is considered the gold standard for TB diagnosis, although it is time-consuming and can take 2-8 weeks. Although mycobacterial culture has been widely accepted as the gold standard for TB diagnosis, the rate of false negative results, which is relatively high, can reduce positive results and increase negative results (Wen et al. 2017).

Methods for determining drug susceptibility tests (DSTs) for *Mycobacterium tuberculosis* use the culture of an isolate in mycobacterial medium containing a drug. Middlebrook 7H9 liquid medium, Lowenstein-Jensen (LJ) egg-based medium as well as Middlebrook 7H11 solid medium are the most commonly used media. The Lowenstein-Jensen solid culture assay as well as the BACTEC MGIT 960 automated culture system are the preferred methods for the determination of DST. Among these culture methods, the BACTEC automated system is the most sensitive; moreover, this approach is also suitable for growing *Mycobacterium tuberculosis* in AFB-negative samples (in relatively shorter detection periods of 7 to 14 days), although

it is costly and sophisticated. For sites on the periphery of health care in TB-endemic communities, this method is unaffordable. The MGIT 960 system is also known to be suitable for MDR-TB detection. In many parts of the world, the MGIT 960 is considered the gold standard in culture. Compared to various detection methods and DST this system has been evaluated, whilst demonstrating specificity between 89—100 % and sensitivity of 100 % for isoniazid (INH) and rifampicin (RIF). Longer culture time (4 to 8 weeks) for DST determination is required when using the LJ solid culture method, which is relatively cheaper as well as simpler, but slow. Using Middlebrook or Cohn solid media containing agar, the period can be shortened. However, its long turnaround time makes it unreliable; moreover, in some localities this medium is not readily available. Some researchers point out that a viable method is a method incorporating appropriate aspects of both microscopy and culture as well as taking robustness into account. At the same time it is technically less demanding. One of the qualitative tests fitting these criteria is the microscopic observational drug susceptibility test (MODS). It includes visualization of *Mycobacterium tuberculosis* growth in the broth, besides

the formation of a cord = pellicle, which is a typical feature. Since it is less technically demanding, relatively rapid, but also cost-effective, this method has been recommended by several studies. While a sensitivity of approximately 86.9 % has been reported for the Lowenstein-Jensen culture, the sensitivity of the MODS method has been estimated to be almost 94 % (Tayyab et al., 2018; Owusu and Newman, 2020).

A recent study assessed the performance of the MODS test for the diagnosis of tuberculosis and MDR-TB, demonstrating the reliability of the MODS method for the detection of the *Mycobacterium tuberculosis* complex as well as determining its sensitivity to RIF and INH, and ultimately highlighting the need to provide support for its widespread use. Only few studies have compared the MODS with the BACTEC MGIT 960 system. Although in these studies the specificity (92.3 % to 97 %) and sensitivity (81 % to 89 %) of the test were slightly lower compared with the current finding, the results were generally consistent with the conclusion that the MODS test is a reliable method. MODS can simultaneously provide culture results with sensitivity results. According to the pooled estimates of the meta-analysis, the specificity and sensitivity of the test ranged from 96—99.4 % and 96—98 % for the detection of resistance to RIF, while it ranged from 95.8—98.6 % and 90—97.7 % for the detection of resistance to INH. Compared with most other earlier studies, the sensitivity of the MODS test in this study for detecting resistance to RIF and INH was slightly lower; however, the specificity was similar. In conclusion, MODS is a rapid as well as inexpensive test that has good performance characteristics for direct diagnosis of tuberculosis as well as detection of multidrug resistance (Şelale and Uzun 2017).

GENETIC TESTING AND NAAT

Nuclear amplification as well as gene-based tests represent a new generation of tools currently used to diagnose tuberculosis. Using DNA-based molecular techniques, these tests allow the identification of bacteria or bacterial particles. These faster techniques provide diagnosis in less time with high accuracy. The usual waiting time for a standard culture lasting several days or even weeks is quite lengthy compared to this new technique, which can provide confirmation of a tuberculosis infection in just a few hours. In immunocompromised people, where the false negative rate is relatively high, these tests are particularly important. Also, some molecular tests, such as DR-MTB or GeneXpert, allow the identification of multidrug-resistant TB infections. A positive nucleic acid amplification test (NAAT) on a single sputum sample is considered sufficient for the diagnosis of active tuberculosis, irrespective of the AFB smear results. In cases of a negative AFB smear with moderate to high suspicion of active tuberculosis, NAAT positivity can be used as a presumptive tuberculosis. It is also known that NAAT cannot be used to rule out pulmonary tuberculosis (Jilani et al. 2021).

Although sputum smear microscopy for acid-fast bacilli (AFB) is a rapid and inexpensive diagnostic option, its sensitivity is low, as has been mentioned several times. Therefore, nucleic acid amplification techniques are relied upon for the rapid detection of *Mycobacterium tuberculosis*, which is essential for early diagnosis as well as treatment, for improving patient's results and last but not least, for the continuous adoption of effective public health measures. Several molecular methods designed for the rapid detection of *Mycobacterium tuberculosis* and drug resistance in clinical samples, including real-time polymerase chain reaction (PCR) or line probe assays, have been developed in recent years (Tang et al. 2017).

Countries known to have a high TB burden primarily use the WHO-approved GeneXpert MTB/ RIF test as a first-line diagnostic tool/technique for tuberculosis. This test can be described as a rapid, unique or automated nucleic acid amplification device based on a cassette. It is one of the fastest and most advanced PCR-based methods recommended for the detection of MTB DNA as well as the resistance to rifampicin. It is based on hemi-nested real-time PCR, which uses a technology of five molecular beacon spanning the *rpoB* gene 81-bp rifampicin resistance determining region (RRDR). The GeneXpert MTB/RIF assay can identify tuberculosis directly from sputum, along with rifampicin resistance, within two hours from analysis. By implementing this assay on a large scale, we can achieve better diagnosis of tuberculosis, especially in populations that are at high risk (Rasool et al. 2019; Mulengwa, Monyama, Lebelo 2021).

According to a recent meta-analysis, in the diagnosis of paediatric pulmonary tuberculosis (PTB), the pooled sensitivity and specificity of Xpert were 68 % and 100 %, respectively. Also in 2013, the WHO recommended the Xpert test for the diagnosis of extra pulmonary tuberculosis (EPTB), and another meta-analysis showed that although this technology has high specificity, its sensitivity for the detection of EPTB is relatively low. The use of Xpert for the diagnosis of musculoskeletal TB cases has also been reported, but the data were too limited. Held et al. reported that compared with a reference standard, that is by culture or histology, Xpert had a specificity of 96.2 % and a sensitivity of 95.6 % in 71 adult spinal cord samples. Gu et al also performed Xpert in 60 cases of both bone and articular TB and found a specificity of 100 % and a sensitivity of 82 % using a composite reference standard (CRS). The diagnostic accuracy of Xpert to identify both musculoskeletal tuberculosis and RIF resistance was of interest in a recent study. After lymphatic and pleural disease, musculoskeletal tuberculosis is the third most common type of EPTB, with the spine as well as the weight-bearing joints being the most vulnerable sites of infection. The data revealed that the pooled specificity and sensitivity of Xpert for the detection of musculoskeletal TB were 83 % and 81 %, respectively. Because musculoskeletal samples may have lower *Mycobacterium tuberculosis* content compared with

sputum from PTB patients, the efficacy of Xpert in diagnosing PTB is lower (specificity 99 % and sensitivity 89 %) according to a previous meta-analysis. This analysis revealed that in the diagnosis of RIF-resistant musculoskeletal TB, this test showed high pooled specificity (96 %) as well as sensitivity (89 %). In conclusion, this study suggests that demonstrating the high specificity and sensitivity of the Xpert MTB/ RIF test in the diagnosis of musculoskeletal TB as well as the detection of RIF resistance may be beneficial, particularly in clinical decision-making. Therefore, more efforts should be made in the future to determine the accuracy of this promising test for the diagnosis of musculoskeletal TB (Wen et al. 2017).

To overcome the limitations of the Xpert test, the new Xpert MTB/ RIF Ultra (Xpert Ultra) test has been developed. Because the Xpert Ultra incorporates two distinct multicopy amplification targets (IS1081 and IS6110) using improved chemistry assay and cartridge design, it provides improved sensitivity for the detection of the *Mycobacterium tuberculosis* complex. As a result, this assay is also able to detect 'traces' of MTB DNA (a new semi-quantitative category whose resistance to RIF is not determined) that were not detectable with the previous version of Xpert, focusing only on the rifampicin resistance determining region (RRDR) of the MTB *rpoB* gene. Improved differentiation of some silent mutations, better detection of RIF resistance in mixed infections, and avoidance of false positives in paucibacillary samples while detecting RIF resistance, have been demonstrated in several analytical laboratory data (Bisognin et al., 2018; Dorman et al. 2018).

According to the results of a recent multicentre study on the diagnostic accuracy of the Xpert Ultra test, it has been shown to have improved sensitivity compared to the standard Xpert for the detection of TB cases in patients with confirmed pulmonary tuberculosis as well as negative sputum smears. Moreover, in all study participants, but also in HIV-infected patients, this test showed excellent sensitivity for detecting TB cases. The high sensitivity of the Xpert Ultra could facilitate not only the diagnosis of tuberculosis in the early stages of the disease in clinical practice, but also the diagnosis of TB in people with HIV infection or with a negative sputum smear (a population with a high mortality rate). Similarly, this increase in sensitivity could be relevant for the diagnosis of extra pulmonary forms of tuberculosis (such as meningitis) and the diagnosis of tuberculosis in children. The specificity of Xpert Ultra for detecting resistance to RIF was not lower compared with that of standard Xpert. Therefore, further studies involving a larger number of rifampicin-resistant samples are still needed so that we can subsequently obtain a better characterization of the accuracy of the Xpert Ultra assay for detecting rifampicin resistance. In summary, this test with its high sensitivity and speed is a suitable tool for the diagnosis of tuberculosis and at the same time for the detection of rifampicin resistance. Compared to Xpert, its increase in sensitivity was most pronounced in patients with lower sputum bacillary loads (Dorman et al. 2018).

Another study compared the diagnostic accuracy of Xpert MTB/ RIF and Xpert Ultra for the detection of pulmonary tuberculosis (PTB), but also for the detection of RIF resistance in individuals with presumable pulmonary tuberculosis. They found Xpert MTB/ RIF to be sufficiently specific and sensitive for the diagnosis of RIF resistance and detection of PTB, which is also consistent with previous findings. Xpert MTB/ RIF was more sensitive for tuberculosis in patients with a positive smear as opposed to those with a negative smear. It was also less sensitive in HIV-positive participants than in HIV-negative participants. Compared with Xpert MTB/ RIF, Xpert Ultra showed lower specificity and higher sensitivity for tuberculosis (especially in HIV-positive and smear-negative participants) and similar specificity and sensitivity for rifampicin resistance. In aggregate, Xpert Ultra and Xpert MTB/ RIF provide more accurate results when performed both, ensuring rapid initiation of MDR-TB treatment (Horne et al. 2019).

World Health Organization-approved molecular lineage tests are also used to diagnose multidrug-resistant tuberculosis. One such test is the MTBDRplus genotype, which can provide rapid detection of MDR-TB directly from positive sputum samples or *Mycobacterium tuberculosis* isolates. However, the utility of this test depends on the type of mutations that are prevalent at a given site and the mutations that are targeted for subsequent determination of drug sensitivity. Mutations in the *rpoB* gene account for almost all rifampicin resistance, while mutations in the *inhA* and *katG* genes cause high levels of isoniazid resistance. All these mutations are detected by the aforementioned assay (Maharjan et al. 2017).

TUBERCULIN SKIN TEST

Although the tuberculin skin test (TST) (also known as the Mantoux test) is more than a century old, it is still used in areas with a high endemic incidence of tuberculosis as a diagnostic tool for diagnosing latent *Mycobacterium tuberculosis* infection. To detect cell-mediated immunity to *Mycobacterium tuberculosis* by a delayed-type hypersensitivity reaction, the TST uses a purified protein derivative (PPD)-tuberculin, which is a heat-induced protein precipitate of ineffective tubercle bacilli. The Mantoux method is commonly used, in which 0.1 mL of fluid containing 5 PPD tuberculin units is injected intradermally into the patient's forearm, followed by assessment of induration after 48 to 72 hours. Depending on the patient's risk factors and the size of the diameter of the induration, the test is interpreted as either negative or positive (induration of 15 mm or more = considered positive; induration threshold reduced to 10 mm = in individuals living in countries with a high prevalence of TB; induration size threshold reduced to 5 mm = most commonly in immunosuppressed individuals). The tuberculin skin test is inexpensive and not difficult to handle. Limitations of this test are related to the need for reading and access to sufficient amount of trained people for subsequent interpretation of

results. False-positive reactions have been observed in patients with Bacillus Calmette-Guerin (BCG) vaccination as well as in individuals with nontuberculous bacterial infection due to cross-reactivity to PPD antigens. In young individuals, such as infants or young children, false-negative results may occur if they are checked within a short period of time (less than 6 to 8 weeks) after TB infection. They may also occur in individuals with predominantly extensive TB disease, then in patients with a viral vaccination that has been administered recently, or in individuals taking immunosuppression in the form of steroids or anti-TNF- α agents. However, this test cannot distinguish latent TB from active TB (Hashash et al. 2020; Gualano et al. 2019; Won et al. 2020).

INTERFERON GAMMA RELEASE ASSAYS

At the beginning of the 21st century, the interferon gamma release assay (IFN- γ) = IGRA was developed as an alternative to TST. This test promotes MTB-sensitized T lymphocytes (from patients' blood) via antigens that are specific for MTB but distinct from most antigens in BCG inoculation or multiple nontuberculous mycobacteria (NTM) infections. Last but not least, it also measures the level of IFN- γ , which is secreted by T lymphocytes. Because the IGRA is a blood test, patients do not have to visit the hospital twice to get the result, which is not true about the TST. In addition, it is less prone to false positive results from NTM infection or BCG inoculation. Compared to TST, it is relatively more sensitive in children or immunosuppressed patients. However, even IGRA cannot distinguish active tuberculosis from latent tuberculosis. IGRA and TST do not assess infection, but immunological memory which is a result of subclinical infection leading to LTBI or current or past active TB. Several meta-analyses suggest that in identifying TB infection, the IGRA test shows relatively higher specificity and sensitivity than the TST test. However, neither TST nor IGRA has demonstrated ideal stability (Won et al. 2020; Yang et al. 2019).

In recent years, several commercially available IFN- γ assays have been developed as a possible screening approach to tuberculosis infection. Assays such as QuantiFERON-TB Gold or QuantiFERON-TB Gold In-Tube and T-SPOT. TB are the main commercially available IGRA products. Although IGRA products do not have cross-reactivity with BCG vaccination (unlike TST), they do have cross-reactivity with some other mycobacteria such as *Mycobacterium szulgai*, *Mycobacterium marinum* or *Mycobacterium kansasii*. In addition, in IGRA products there is reduced sensitivity to LTBI detection in children and immunocompromised patients. They also fail to distinguish between distant and recent infections (Kim, Jo, & Shim, 2019; Yang et al. 2019).

QuantiFERON-TB Gold In-Tube (QFT-GIT) uses whole blood, a minimum of 3 ml, which is drawn into three coated heparinized tubes with lyophilized antigen: 1. antigen-coated

tube; 2. mitogen control tube to ensure the presence of viable cells; 3. null control tube. In response to the MTB antigen, the concentration of interferon gamma is subsequently determined by ELISA. As the previous studies have adequately demonstrated the role of CD8+ T cell responses in *Mycobacterium tuberculosis* infection, QuantiFERON-TB Gold Plus (QFT-Plus) was introduced as a next-generation QFT-GIT. This new QFT-Plus contains two tubes of antigens (TB1 and TB2): peptides derived from CFP-10 and ESAT-6 (with TB 7.7 removed) are contained in the TB1 tube, which was designed to elicit a CD4+ T cell response; the TB2 tube contains peptides of the same length as TB1 and, in addition, includes newly designed peptides that stimulate IFN- γ production by CD8+ and CD4+ T cells. Similar accuracy of the QFT-GIT and QFT-Plus assays has been reported in recent studies, where these assays showed a higher CD8+ T cell response to recent *Mycobacterium tuberculosis* exposure, in contrast to remote exposure in contact screening (Hashash *et al.* 2020; Kim, Jo, & Shim 2019).

QFT-Plus and QFT-GIT have been compared by several studies, and as a result, high concordance between these tests has been demonstrated. Despite the absence of the TB7.7 antigen, the QFT-Plus was as accurate as the QFT-GIT in volunteers who were not infected with *Mycobacterium tuberculosis* and in patients with active tuberculosis. In health care workers, immunocompromised individuals or patients at risk of tuberculosis, concordance between QFT-Plus and QFT-GIT was relatively high (95.6 %, 93.7 % and 96.6 %, respectively). A major advantage of the QFT-Plus assay is the ability to provide information regarding additional CD8+ T cell responses to distinguish between latent and active TB or between old and recent infections, as well as to improve TB detection in immunocompromised patients. (Won *et al.* 2020).

The sensitivity of QFT-Plus compared to QFT-GIT in individuals co-infected with HIV and TB remains poorly characterized. A study conducted in Zambia has recently demonstrated up to 85 % sensitivity of QFT-Plus in culture-positive individuals with active TB and co-infection with HIV. Although a direct comparison with QFT-GIT was not included in this study, the authors argued that in HIV co-infected patients, QFT-Plus has a relatively higher sensitivity compared to QFT-GIT, as a sensitivity of 63 % was already observed using QFT-GIT in an earlier study (in the same setting). Like when using QFT-GIT, this study also demonstrated a reduced positivity rate in HIV-infected individuals with declining CD4+ T cell counts. In spite of the fact that QFT-Plus has a higher sensitivity compared to QFT-GIT in HIV-positive patients with tuberculosis, direct comparison of QFT-Plus with QFT-GIT, along with adjustment for CD4+ T cell count, is needed to accurately demonstrate the increased sensitivity of QFT-Plus in this population. Although QFT-Plus has been marketed as a promising alternative that provides improved performance (compared to QFT-GIT) by adding CD8+ T

cell response, published studies directly comparing QFT-GIT to QFT-Plus have not revealed any remarkable improvement in the performance of this assay in individuals with tuberculosis, low-risk populations, or high-risk groups. Further research in children and immunocompromised individuals is necessary to determine the performance of the QFT-Plus in these groups (Shafeque *et al.* 2020).

The T-SPOT. TB assay uses enzyme-linked immunospot (ELISPOT) methodology to determine the number of T lymphocytes sensitized to TB antigens due to exposure to TB mycobacteria. Sensitized T lymphocytes are detected by capturing secreted IFN- γ after *in vitro* stimulation with MTB antigens [culture filtrate protein 10 (CFP10) and early secreted antigen target-6 (ESAT-6)]. IFN- γ is captured on the membrane surface by specific antibodies and is subsequently observable as speckles by adding an appropriate substrate. The number of spots obtained will represent the number of sensitized T lymphocytes (in the sample). According to the number of spots formed, the results of the T-SPOT. TB will be reported as negative, positive, borderline or invalid. The T-SPOT. TB test contains a borderline for better identification of individuals who are infected with tuberculosis. The only IGRA borderline category test is the T-SPOT. TB test. The borderline was created to increase test resolution for results around the cut-off point, thereby also to decrease the uncertainty associated with results on either side of the single cut-off point. If the cut-off point between negative and positive results is determined by using 6 point pulses (after subtracting the zero control pulses), optimal sensitivity and maximum specificity of the test are achieved. A positive result will be obtained if the number of spots induced by the MTB antigen is greater than or equal to eight points after subtraction of the null control. If the number of spots induced by the MTB antigen is less than or equal to four points after subtraction of the null control, a negative result will be obtained (Hashash *et al.*, 2020; Rego *et al.* 2018).

T-SPOT. TB is a new method for screening *Mycobacterium tuberculosis* infection. However, it is questionable whether T-SPOT. TB should become a substitutable alternative to TST for screening *Mycobacterium tuberculosis* infections. Therefore, a retrospective analysis was performed to evaluate the performance of the two methods. The performance of the TST was compared with that of the T-SPOT. TB test in the detection of active tuberculosis. In this study, the pooled sensitivities of the T-SPOT. TB and TST tests were 88.3 % and 76.7 %, respectively. The T-SPOT. TB test showed comparatively higher sensitivity compared with the TST, which was also consistent with the results of some previous meta-analyses. However, neither of these tests was sufficiently accurate to be used to detect active TB disease. Because the performance of the two tests is comparable, the choice of either the T-SPOT. TB or TST test should rather be based on other considerations, including benefits, costs, or resources (Yang *et al.* 2019).

TUBERCULIN SKIN TEST VERSUS INTERFERON GAMMA RELEASE-BASED ASSAYS

For a century, TST has been the dominant test for detecting *Mycobacterium tuberculosis* infection. Interferon gamma release assays have been available for nearly a decade and dozens of studies have compared the performance of both types of assays (IGRAs). The benefits of IGRAs even have led some experts to the conclusion to “discontinue” TST, even in paediatrics. However, due to the lack of data, doubts remain as to whether the use of IGRAs is the best option in young children.

The results of the Tuberculosis Epidemiology Study Consortium have recently been reported by a team of researchers interested in assessing tuberculosis infection and disease in 3 493 children in 11 countries over a 4-year period. In fact, this is the largest study in the US to compare outcomes of both IGRAs (T-SPOT. TB and QuantiFERON-TB Gold In-Tube) with TST in the same population. About 92 % of participants were born in countries where the BCG vaccine is routinely administered, that is outside the US. There was 80 % overall concordance between IGRAs and TST, and more than 90 % of discordant results were IGRA-negative and TST-positive. The lowest concordance as well as the highest proportion of IGRA-negative and TST-positive results were exhibited in children younger than 2 years, not born in the US, which was probably due to the recent administering of the BCG vaccine. Concordance between the two IGRAs was relatively high (97 % for children born outside the US and 93 % for US born children), supporting the collective recommendation that one IGRA should not be favoured over the other (Starke 2020).

In predicting the development of active tuberculosis among high-risk individuals living in TB-endemic countries, a large prospective cohort study in the United Kingdom demonstrated that IGRA positivity was significantly superior to the TST-5 mm and TST-10 mm strategies. In contrast to all other tests and TST thresholds (≤ 75 %), TST-5 mm identified the greatest proportion of participants progressing to active TB (64 of 77 tested, representing 83 %). The WHO LTBI management organization used five studies related to TST and IGRAs (from countries with high TB incidence), finding different relative risks for each test (2.03 for IGRAs and 1.49 for TST), and estimated pooled hazard ratios for negative and positive tests. It was concluded that neither test was superior for predicting progression to active TB, and that TST remained an acceptable option for children younger than 5 years. A recent review of comparative data did not provide reliable evidence to support the claim that IGRAs are superior to TST when used without evidence of active

TB in HIV-infected patients. Because there are not sufficient quality evidence for the recommendation IGRAs, WHO suggests that in low- and middle-income countries, IGRAs should not substitute TST. Direct comparison of the two tests has been conducted primarily in countries with middle- to low-economic resources and high TB burden, so it remains unclear which test better identifies LTBI (Gualano et al., 2019; Chandrasekaran et al., 2018).

CONCLUSION

Persons with HIV infection and AIDS, migrants and those infected with multidrug-resistant strains of tuberculosis have become new risk groups. Elimination of the disease is still hampered by high rates of multidrug-resistant TB and by the spread of TB in vulnerable groups of the population, such as people addicted to alcohol and drugs, migrants from countries with a high number of TB cases (in the Slovak Republic, main risky group are migrants from Ukraine). The clinical and immunopathological interaction between TB and COVID-19 is not yet fully understood and studied.

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REFERENCES

1. Bisognin F. et al. 2018. Improvement of *Mycobacterium tuberculosis* detection by Xpert MTB/RIF Ultra: A head-to-head comparison on Xpert-negative samples. In *PloS one* [online]. 2018, vol. 13, no. 8 [cit. 2022-01-10]. Available on: <<https://journals.plos.org/plosone/article?id=10.1371/journal.pone.0201934>>
2. Dorman SE et al. 2018. Xpert MTB/RIF Ultra for detection of *Mycobacterium tuberculosis* and rifampicin resistance: a prospective multicentre diagnostic accuracy study. In *The Lancet Infectious Diseases* [online]. 2018, vol. 18, no. 1 [cit. 2022-01-24]. Available on: <<https://www.sciencedirect.com/science/article/pii/S1473309917306916>>
3. Dzodanu EG et al. 2019. Diagnostic Yield of Fluorescence and Ziehl-Neelsen Staining Techniques in the Diagnosis of Pulmonary Tuberculosis: A Comparative Study in a District Health Facility. In *Tuberculosis research and treatment* [online]. 2019, vol. 2019 [cit. 2022-01-17]. Available on: <<https://www.hindawi.com/journals/trt/2019/4091937/>>
4. Gualano G et al. 2019. Tuberculin skin test — Outdated or still useful for Latent TB infection screening? In *International journal of infectious diseases* [online]. 2019, vol. 80 [cit. 2022-02-02]. Available on: <[https://www.ijidonline.com/article/S1201-9712\(19\)30061-X/fulltext](https://www.ijidonline.com/article/S1201-9712(19)30061-X/fulltext)>
5. Hashash JG et al. 2020. Approach to Latent Tuberculosis Infection Screening Before Biologic Therapy in IBD Patients: PPD or IGRA? In *Inflammatory bowel diseases* [online]. 2020, vol. 26, no. 9 [cit. 2022-01-27]. Available on: <<https://academic.oup.com/ibdjournal/article/26/9/1315/5850157?login=true>>

6. Horne DJ *et al.* 2019. Xpert MTB/RIF and Xpert MTB/RIF Ultra for pulmonary tuberculosis and rifampicin resistance in adults. In *The Cochrane database of systematic reviews* [online]. 2019, vol. 6, no. 6 [cit. 2022-01-22]. Available on: <<https://www.cochranelibrary.com/cdsr/doi/10.1002/14651858.CD009593.pub4/full>>.
7. Chandrasekaran P *et al.* 2018. Tuberculin skin test and QuantiFERON-Gold In Tube assay for diagnosis of latent TB infection among household contacts of pulmonary TB patients in high TB burden setting. In *PloS one* [online]. 2018, vol. 13, no. 8 [cit. 2022-02-04]. Available on: <<https://journals.plos.org/plosone/article?id=10.1371/journal.pone.0199360>>
8. Jilani TN *et al.* 2021. Active Tuberculosis [online]. Treasure Island (FL): StatPearls Publishing 2021. [cit. 2022-01-28]. Available on: <<https://www.ncbi.nlm.nih.gov/books/NBK513246/>>. ISBN 30020618.
9. Kim SH — Jo KW — Shim TS 2019. QuantiFERON-TB Gold PLUS versus QuantiFERON-TB Gold In-Tube test for diagnosing tuberculosis infection. In *The Korean journal of internal medicine* [online]. 2019, vol. 35, no. 2 [cit. 2022-02-02]. Available on: <<https://www.ncbi.nlm.nih.gov/pmc/articles/PMC7061006/>>.
10. Maharjan E *et al.* 2017. Use of Genotype MTBDRplus Assay for Diagnosis of Multidrug-Resistant Tuberculosis in Nepal. In *International Scholarly Research Notices* [online]. 2017, vol. 1, no. 1 [cit. 2022-03-04]. Available on: <<https://www.hindawi.com/journals/isrn/2017/1635780/>>.
11. Mulengwa DL, Monyama M CH, Lebelo SL 2021. Evaluation of the GeneXpert MTB/RIF assay performance in sputum samples with various characteristics from presumed pulmonary tuberculosis patients in Shiselweni region, Eswatini. In *Infectious diseases* [online]. 2021, vol. 54, no. 3 [cit. 2022-01-19]. Available on: <<https://www.tandfonline.com/doi/full/10.1080/23744235.2021.1992005>>
12. Owusu E, Newman MJ 2020. Microscopic Observation Drug Susceptibility (MODS) Assay: A Convenient Method for Determining Antibigram of Clinical Isolates of Mycobacterium tuberculosis in Ghana. In *Medical sciences* [online]. 2020, vol. 8, no. 1 [cit. 2022-01-25]. Available on: <<https://www.mdpi.com/2076-3271/8/1/5/htm>>
13. Rasool G *et al.* 2019. Detection of Mycobacterium tuberculosis in AFB smear-negative sputum specimens through MTB culture and GeneXpert® MTB/RIF assay. In *International journal of immunopathology and pharmacology* [online]. 2019, vol. 33 [cit. 2022-01-17]. Available on: <<https://www.ncbi.nlm.nih.gov/pmc/articles/PMC6360468/>>
14. Rego K *et al.* 2018. Utility of the T-SPOT®. TB test's borderline category to increase test resolution for results around the cut-off point. In *Tuberculosis* [online]. 2018, vol. 108 [cit. 2022-02-03]. Available on: <<https://www.sciencedirect.com/science/article/pii/S1472979217303694>>.
15. Santos TCS *et al.* 2019. Radiological aspects in computed tomography as determinants in the diagnosis of pulmonary tuberculosis in immunocompetent infants. In *Radiologia brasileira* [online]. 2019, vol. 52, no. 2 [cit. 2022-01-08]. Available on: <<https://www.scielo.br/rb/a/KC54yfbwypPG3P5L6Th8PPk?lang=en>>
16. Şelale DS, Uzun M. 2017. The value of microscopic-observation drug susceptibility assay in the diagnosis of tuberculosis and detection of multidrug resistance. In *APMIS: acta pathologica, microbiologica, et immunologica Scandinavica* [online]. 2017, vol. 126, no. 1 [cit. 2021-11-10]. Available on: <<https://onlinelibrary.wiley.com/doi/10.1111/apm.12783>>
17. Shafeque A *et al.* 2020. Fourth-Generation QuantiFERON-TB Gold Plus: What Is the Evidence? In *Journal of clinical microbiology* [online]. 2020, vol. 58, no. 9 [cit. 2022-01-04]. Dostupné na internete: <<https://journals.asm.org/doi/full/10.1128/JCM.01950-19>>.
18. Starke JR 2020. Tuberculin Skin Test Versus the Interferon-γ Release Assays: Out With the Old, In With the New. In *Pediatrics* [online]. 2020, vol. 145, no. 1 [cit. 2022-01-04]. Available on: <<https://publications.aap.org/pediatrics/article/145/1/e20193021/36908/Tuberculin-Skin-Test-Versus-the-Interferon-Release>>
19. Tang T *et al.* 2017. Evaluation of GeneXpert MTB/RIF for detecting Mycobacterium tuberculosis in a hospital in China. In *The Journal of international medical research* [online]. 2017, vol. 45, no. 2 [cit. 2021-12-17]. Available on: <<https://journals.sagepub.com/doi/10.1177/0300060517698618?icid=int.sj-full-text-similar-articles.2>>
20. Tayyab N *et al.* 2018. Direct Susceptibility Testing on MGIT 960 TB System: A Rapid Method for Detection of Drug Resistant Tuberculosis. In *Journal of the College of Physicians and Surgeons* [online]. 2018, vol. 28, no. 8 [cit. 2022-01-10]. Available on: <https://www.researchgate.net/profile/Gohar-Zaman-2/publication/326744173_Direct_Susceptibility_Testing_on_MGIT_960_TB_System_A_Rapid_Method_for_Detection_of_Drug_Resistant_Tuberculosis/links/5bc519a792851cae21a7e4e9/Direct-Susceptibility-Testing-on-MGIT-960-TB-System-A-Rapid-Method-for-Detection-of-Drug-Resistant-Tuberculosis.pdf>
21. Wen H *et al.* 2017. Diagnostic accuracy of Xpert MTB/RIF assay for musculoskeletal tuberculosis: a meta-analysis. In *Infection and drug resistance* [online]. 2017, vol. 10 [cit. 2021-12-19]. Available on: <<https://www.dovepress.com/diagnostic-accuracy-of-xpert-mtbrif-assay-for-musculoskeletal-tubercul-peer-reviewed-fulltext-article-IDR>>
22. Won D *et al.* 2020. Comparative Results of QuantiFERON-TB Gold In-Tube and QuantiFERON-TB Gold Plus Assays for Detection of Tuberculosis Infection in Clinical Samples. In *Journal of clinical microbiology* [online]. 2020, vol. 58, no. 4 [cit. 2022-02-03]. Available on: <<https://journals.asm.org/doi/full/10.1128/JCM.01854-19>>.
23. Yang J *et al.* 2019. Correlation between the tuberculin skin test and T-SPOT. TB in patients with suspected tuberculosis infection: A pilot study. In *Experimental and therapeutic medicine* [online]. 2019, vol. 18, no. 3 [cit. 2022-02-05]. Available on: <<https://www.spandidos-publications.com/etm/18/3/2250>>
24. Zellweger JP *et al.* 2020. The diagnosis of latent tuberculosis infection (LTBI): currently available tests, future developments, and perspectives to eliminate tuberculosis (TB). In *La Medicina del lavoro* [online]. 2020, vol. 111, no. 3 [cit. 2022-01-25]. Available on: <<https://www.ncbi.nlm.nih.gov/pmc/articles/PMC7809945/>>

New insight on segmental organisation of human spinal cord

Nový náhľad na segmentálnu organizáciu ľudskej miechy

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ABSTRACT

Introduction: Number of studies showing observations of intradural intersegmental connections between neighbouring spinal cord fila radicularia is raising, similar is with the works describing variabilities of innervation areas of spinal nerves plexus terminal branches.

Research Objectives: was to point out on individual regional differences in the innervation areas of the upper and lower limb based on quite frequently found nerve connections and variations.

Core of work: The common segmentary origin of the nerves explains the frequent observation of connections between nerves and lines of overlapping in the regions that peripherally correspond to the above-mentioned segments. Connections in the periphery are not something random and cannot be assigned to anomalies. Their presence brings certain regularity. In their location, there is certain dependence, reflecting the complex genesis and explanation in segmental body structure. This group of intersegmental anastomoses is very complicated in the sacral region, where a large number of anastomoses make the impression of the presence of the plexus. In other cases, however, between the dorsal branches of the lumbar nerves only isolated connections are found.

Conclusions: The classical image about the spinal cord segmental arrangement should take into consideration/account also some regional specifics.

Keywords: spinal nerves, intersegmental connections, regional arrangement

ABSTRAKT

Úvod: V literatúre sa množia práce s nálezmi intradurálnych intersegmentálnych spojok medzi susednými koreňovými vláknami miechy, rovnako pribúdajú práce o variabilitách inervačnej oblasti koncových vetiev miechových spleťí.

Cieľom výskumu: bolo poukázať na individuálne regionálne rozdiely v inervačných oblastiach hornej a dolnej končatiny na základe relatívne často nachádzaných nervových spojok a variácií.

Jadro práce: Spoločný segmentálny pôvod nervov vysvetľuje časté pozorovanie spojok medzi nervami a oblasti prekrývania v oblastiach, ktoré periférne zodpovedajú vyššie uvedeným segmentom. Spojenia na periférii nie sú ničím náhodným a nemožno ich priradiť k anomáliám. Ich prítomnosť prináša určitú pravidelnosť. V ich umiestnení existuje určitá závislosť, ktorá odráža zložitú genézu a vysvetlenie v segmentálnej stavbe tela. Táto skupina intersegmentálnych anastomóz je veľmi komplikovaná v sakrálnej oblasti, kde veľké množstvo anastomóz vytvára dojem prítomnosti splete. V iných prípadoch sa však medzi dorzálnymi vetvami bedrových nervov nachádzajú iba izolované spojenia.

Záver: Klasickú predstavu čisto segmentálnej organizácie miechy treba „obohatiť“ aj o určité oblastné (regionálne) špecifiká.

Kľúčové slová: miechové nervy, intersegmentálne spojky, regionálna organizácia

INTRODUCTION

In many of our previous works, we focused on the variability in the origin and course of some spinal nerve terminal branches and their plexuses (Matejčík 2019, Haviarová 2017). We also find works dealing with the same issue in foreign scientific literature (Bartynski 2010, Harshavardhana 2014, Rabai 2016, Yang 2016, Wu 2015). Numerous intersegmental connections, overlapping areas of the neighboring dermatomes and myotomes, and border areas forced us to think about the classic scheme of the segmental arrangement of the innervation areas of the human body and to take into account the most frequently occurring segmental variations and assign them to the existing standards. Extremities (upper and lower) are a very frequent location of nerve damage (either in the sense of a conduction disorder or interruption as a result of another pathological process) and its subsequent treatment, therefore we will focus mainly on them: their sensory and motor innervation comes from 2 thickened sections of the spinal cord: *intumescentia cervicalis* for the upper limbs (giving rise to the network for the upper limb — *plexus brachialis*) and *intumescentia lumbosacralis* for the lower limbs (giving rise to the lumbar and sacral plexuses — *plexus lumbalis et plexus sacralis*).

Research Objectives was to point out on individual regional differences in the innervation areas of the upper and lower limb based on quite frequently found nerve connections and variations.

CORE OF WORK:

Axonal pathways to the terminal regions of innervation in the upper limb nerves (Fig.1).

Anastomoses between nerves in the periphery, reducing or enlarging of innervation regions of nerves and sometimes even complete replacement of one nerve by another one, is expression of the complexity of forming of limbs.

A large number of segments (neurotomes, myotomes, dermatomes), from which the upper limb is developing, complexity and instability of the formation is reflected in the complexity of pathways of the axons and in anatomical differences of the peripheral nerves.

In cases, where 2 or 3 nerves with a common source of origin (in the sense of belonging to the uniform or adjacent segments), participate in innervations of any region of a limb, the axons may pass through the area in arrangement of one of more nerves. As an example, we can show possible pathways of axons to innervations of the dorsum of the hand, in which branches of ulnar, radial nerves and sometimes musculocutaneous nerve participate. Ulnar nerve contains

axons of the C7, C8 and T1 segments. Radial nerve contain axons from all segments involved in the formation of brachial plexus. Therefore, C7 and C8 are the segments, which are common for the ulnar and radial nerves. The axons of the cells of these segments can pass to the innervations regions (skin segment of the dorsum of the hand) as in the arrangement of the ulnar nerve, so in the arrangement of the radial nerve.

In the radial type of innervations, the radial nerve is innervating the whole region (Fig. 1), in the ulnar type the ulnar nerve. The common segmentary origin of the nerves explains the frequent observation of connections between nerves and lines of overlapping in the regions that peripherally correspond to the above-mentioned segments. The amount of connections and the size of the overlapping zones are unstable. Variability is an expression of instability of the peripheral nervous system.

Axonal pathways to the lower limb innervation regions (Fig. 2).

The complexity of the formation of the lower limb, which involves a large number of segments, as well as the assimilation of lumbar and sacral segments has resulted in observations of connections between nerves and differences in innervation areas of the nerve.

All lumbar and sacral segments are the sources of the lower limb nerves. For example, axons L1-L4 constitute basic nerves on the front extensoric side of the lower limb. The axons of the last lumbar and sacral segments S1-S4 are basically involved in the formation of common peroneal nerve and the tibial nerve (branches from the sciatic nerve, Fig. 2).

Genetic relatedness of segments of sources of nerves enables the course of axons to the final innervation territories in several nerves that have common source of origin in the sense belonging to their homonymous or adjacent segments. This is particularly important in that region where two or three nerves innervate any region, for example, the pathways of axons to the tarsal region.

In some cases, the saphenous, the deep peroneal, the superficial peroneal and the sural nerves participate in innervations (Fig. 2). The mentioned nerves have in their arrangement of nerves of the lumbar and sacral plexuses, so on the periphery, in this case, the tarsal region, we can observe in the borders of L4, L5 and S1 the nerve branches of the lumbar plexus (saphenous nerve) and sacral plexus (superficial and deep peroneal nerves, sural nerve, anastomoses between them and the overlapping zones). In case (Fig. 2), when the axons pass from the L4 and L5 to the final territory, in particular in the arrangement of superficial and deep peroneal nerves, only the branches of mentioned nerves participate in innervations of the instep within the borders of L4-L5.

Figure 1: Axonal pathways to the terminal upper limb innervation areas (Haviarová 2017).

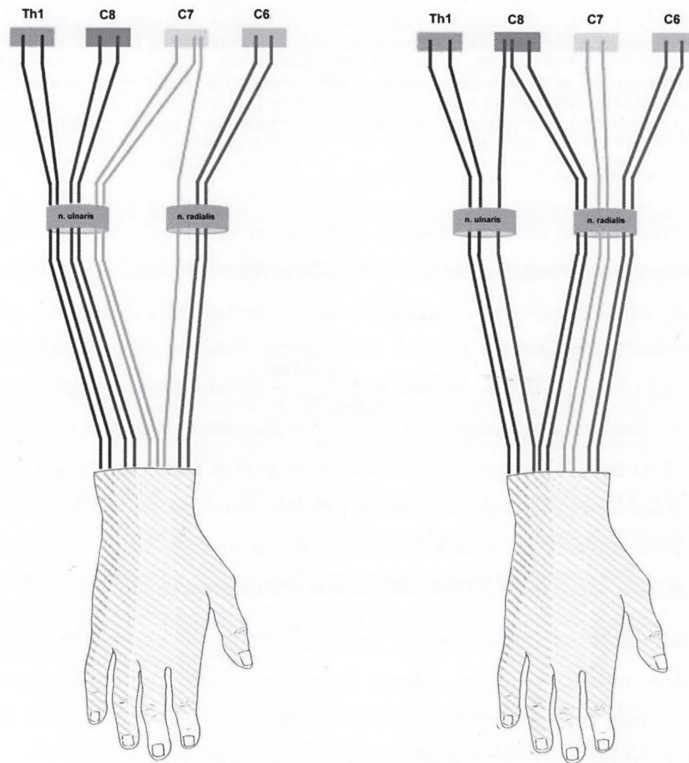


Figure 2: Axonal pathways to the terminal lower limb innervation areas (Haviarová 2017).

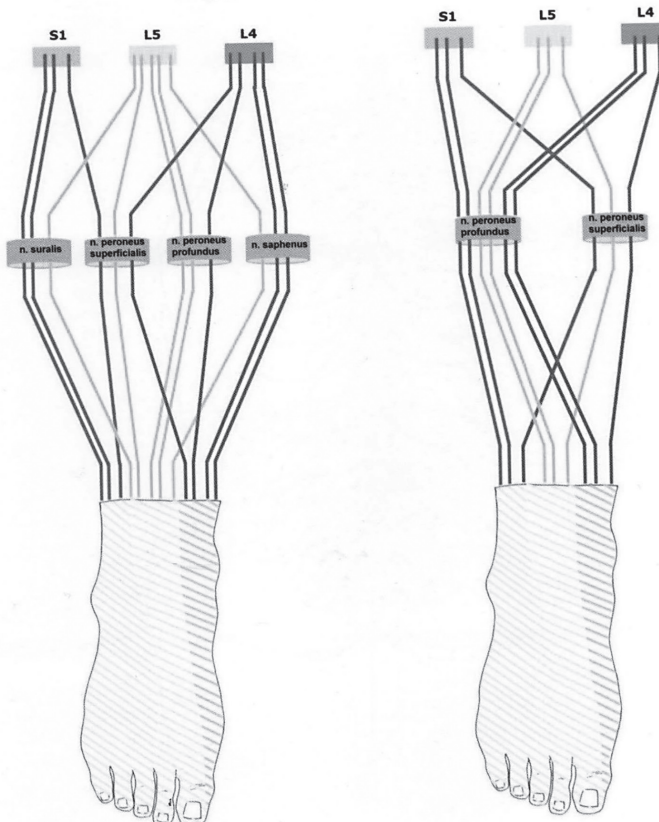
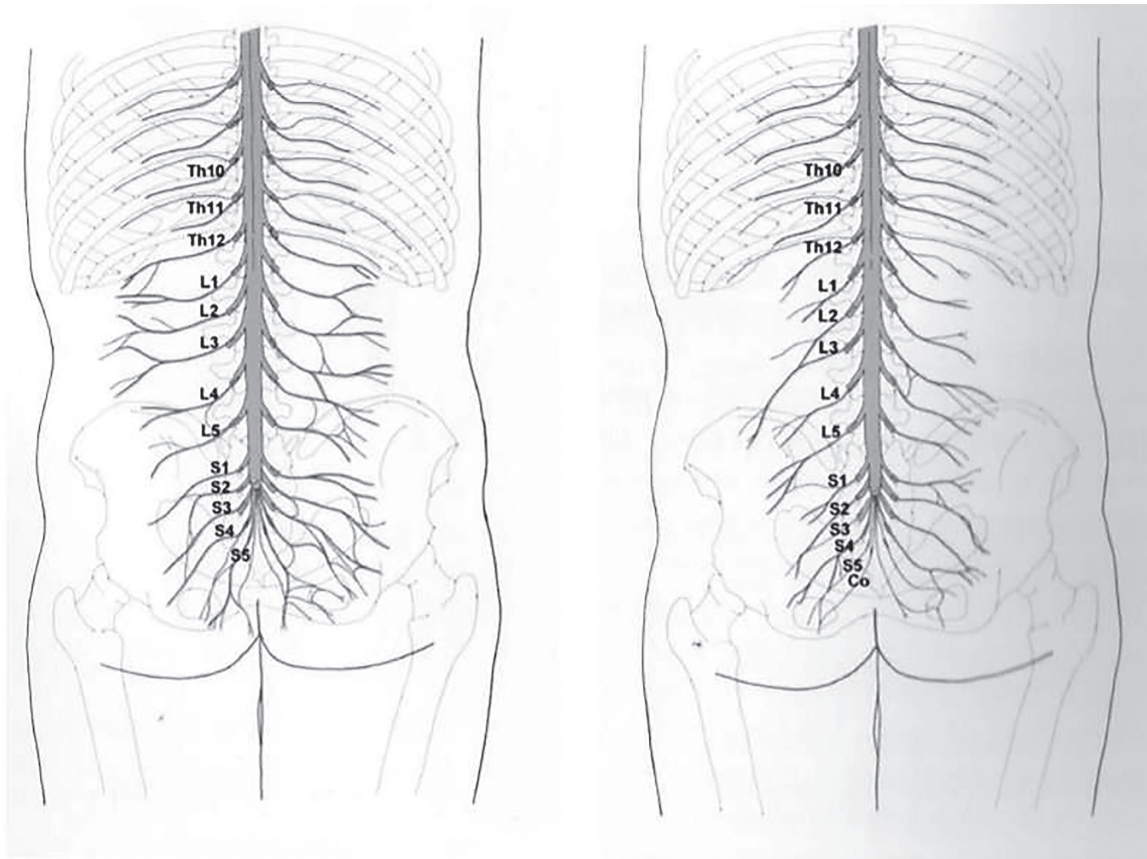


Figure 3: Nerve connections between dorsal branches of lumbar and sacral spinal cord segments (Haviarová 2017).



This example shows that the principal issue is seen only after clarification of the complex of the nerves involved in the innervations of any region, (because the differences of the formation level of limbs or plexuses are reflected in the projections of segments at the periphery).

Various ways axons to the final territories are possible, especially in the localisation of zones of overlapping and replacing the territories of extending branches of a single nerve with branches of a second one.

It is seen that the common origin of the lateral cutaneous femoral nerve and femoral nerve (L1-L2) explains the location of connectors on the periphery of the borders L2. In addition, the presence of numerous connections between the obturator nerve and the femoral nerve finds its clarifications here.

The figure shows that the axons of the segments L2, L3 and L4 can pass to their final territories in the arrangement of the femoral nerve or the obturator nerve and depending on it, the nature of the branching, in the sense of the presence or absence of specific nerve branches of the mentioned nerves as well as overlapping zones, will be differentiated.

The axons of segments L4 pass in the arrangement of the peroneal nerves and saphenous nerve which explains the fact

that, in some cases, peroneal nerve participates in innervations of — the tarsal region, and in others, its terminal branches are depleted at a much higher level. In the region of L4 on the periphery, there is the region of overlapping due to connections between both mentioned nerves.

The common segmentary origin of the sciatic nerve explains the frequent occurrence of connections and overlapping zones observed on the posterior part of the femur and on the the dorsum of the ankle.

Connections in the periphery are not something random and cannot be assigned to anomalies. Their presence brings certain regularity. In their location, there is certain dependence, reflecting the complex genesis and explanation in segmental body structure.

Anastomoses between the dorsal branches of the lumbosacral plexus (Fig. 3).

In some cases (Fig. 3) between the dorsal branches of the lumbar nerves from L1 to L5, especially from the right, a large number of connections are present. The form of connections varies. Connections of the higher or lower located nerve can be observed, from which fascicles separate and secondary branch is formed (Bartynski 2010). Sometimes, a portion of axons

entering the overlying nerve passes into the arrangement of the lower located nerve (Harshavardhana 2014), or the nerves belonging to two adjacent segments connect together with an arc, which makes it difficult to estimate the direction of the passing axons (Leijinse 2016).

This group of intersegmental anastomoses is very complicated in the sacral region on the back surface of the sacrum, where a large number of anastomoses make the impression of the presence of the plexus. In other cases (Fig. 3), however, between the dorsal branches of the lumbar nerves only isolated connections are found.

CONCLUSION

As stated by Leijinse and D'Herde in their work (Leijinse 2016), on 5 human spinal cords (focusing on the cervical and upper thoracic region) they observed several intersegmental intradural junctions, while the fila radicularia participating in the formation of the brachialis plexus were thicker than the fila radicularia of the others areas, their creation was also attended by connections from peripheral areas.

As a result of such observations, a dual idea of the organization of the spinal cord is proposed — not only segmental, but also regional (regional): *fila radicularia* of the anterior roots emerging from the *sulcus anterolateralis* and *fila radicularia* of the posterior roots entering the *sulcus posterolateralis* have a regionally determined density and thickness of the fibers and are peripherally grouped towards to their intervertebral opening (*foramen intervertebrale*), from which they emerge already in the “classic” segmental arrangement (Leijinse 2016). Such a dual idea of segmental and regional distribution of root fibers corresponds more to the latest functional-morphological observations (Leijinse 2016).

Conflict of interests. The authors state that they have no any conflict of interests.

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REFERENCES

1. Bartynski WS, Kang MD, Rothfus WE (2010). Adjacent Double-Nerve Root Contributions in Unilateral Lumbar Radiculopathy. *AJNR Am J Neuroradiol.* 2010; 31: 327 — 33.
2. Harshavardhana NS, Dabke HV (2014): The furcal nerve revisited *Orthopedic Reviews* 2014; 6: 5428. (doi: 10.4081/or.2014.5428)
3. Haviarová Z, Matejčík V, Kuruc R (2017). Nervové spojky medzi spleťami vo vnútri chrbticevého kanála a segmentálna organizácia ľudskej miechy = Intraspinálna anastomózy v oblasti plexusov a segmentálna organizácia ľudskej miechy. In: *Nové prístupy a trendy výskumu v morfológických disciplínach: 20. Košický morfológický deň. Košice, Typopress. s. 43 — 47. ISBN 978-80-8129-052-7 [Košický morfológický deň. 20., Košice, 25. 5. 2017].*
4. Leijinse JN and D'Herde K (2016): Revisiting the segmental organization of the human spinal cord. *J. Anat.* 2016; 229: 384 — 393. (doi: 10.1111/joa.12493)
5. Matejčík V, Haviarová Z, Kuruc R et al. (2019) *Intraspinálna variácia nervových koreňov.* Springer, Switzerland, 181 p. ISBN 978-3-030-01685-2
6. Rabai F, Sessions R, Seubert ChN (2016): Neurophysiological monitoring and spinal cord integrity. *Best Practice & Research Clinical Anaesthesiology* 2016; 30: 53 — 68. (<http://dx.doi.org/10.1016/j.bpa.2015.11006>)
7. Yang H, Gil Y, Kim S et al. (2016): From the brachial plexus to the hand, multiple connections between the median and ulnar nerves may serve as bypass routes for nerve fibres. *The Journal of Hand Surgery (European Volume)* 41E 2016; 6: 648 — 656. (doi: 10.1177/1753193415622760)
8. Wu M, Cui J, Xu D et al. (2015). Neuroanatomical characteristics of deep and superficial needling using LI11 as an example. *Acupunct Med.* 2015 Dec; 33(6): 472 — 7. doi: 10.1136/acupmed-2015-010882. Epub 2015 Oct 21. PMID: 26490338; PMCID: PMC4860970.

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3. Sibbald SL, Wathen CN, Kothari A (2016). An empirically based model for knowledge management in health care organizations. *Health Care Manage Rev* (abbreviated journal title) 2016; 41 (1 — 3): 64 — 74. Doi: 10.1097/HMR.00000000 000 000 046.

Electronic document:

4. Mládková L (2014). Tacit knowledge — the human dimension of knowledge. New Delhi: Asian Research Consortium; 2014 [online] [cit.2016-06-12]. Available from: <http://www.indianjournals.com/jor.aspx?target=ijor.ijrobbm&volume=2&issue=2&article=editorial>

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Revamil®



A care



Indikácie

- ošetrovanie akútnych a chronických rán – dekubity, chronické vredy, vredy diabetickej nohy, vredy predkolenia, onkologické rany, chirurgické rany, infikované a nekrotické rany, ošetrovanie popálenín (aj po opalovaní)
- ošetrovanie odrenín, škrabančov a menších poranení

Fakty a výhody

- Protizápalové a antibakteriálne účinky
- Prírodné antibiotikum, antioxidant
- Zabezpečuje vlhké prostredie v rane
- Redukuje zápach
- Bez alergických reakcií a vedľajších účinkov

Revamil je hydrofilný produkt, ktorý obsahuje 100% sterilný lekársky med, ktorý je získavaný z kontrolovaného chovu včiel, neobsahuje stopy pesticídov. Je určený na ošetrovanie akútnych a chronických rán, infikovaných rán a popálenín. Rýchle hojenie je dosiahnuté v kombinácii vlhkého prostredia rany, antibakteriálnych vlastností a protizápalových účinkov prípravku Revamil.

Revamil sa z veľkej časti skladá z cukrov, malého množstva vody, organických zlúčenín a enzýmov. Enzým glukooxidáza sa do medu dostáva prostredníctvom včiel a spoločne s ďalšími faktormi zaisťuje antibakteriálny účinok Revamilu. Pri kontakte s ranou sa med rozriedi s vlhkosťou rany a aktivuje sa enzým glukooxidáza. Enzým glukooxidáza je zodpovedný za kontinuálnu tvorbu veľmi malého množstva peroxidu vodíka (0,003%). Táto koncentrácia peroxidu vodíka je dostatočne vysoká na to, aby usmrtila patogénne baktérie a naopak nepoškodila ranu vo fáze hojenia.

A care, s.r.o.

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