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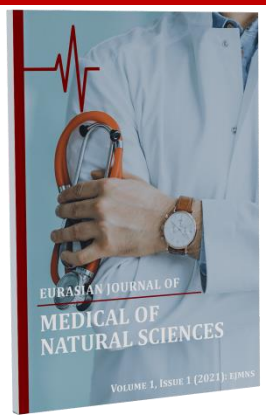

ULTRASOUND ELASTOGRAPHY OF MUSCLES IN CHILDREN WITH CEREBRAL PALSY

[1]Ahmedov E.A.
[2]Yusupalieva G.A.
[1,2]Tashkent Pediatric Medical Institute
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ABSTRACT

Ultrasound elastography (UE) has become a popular non-invasive imaging technique for determining the elasticity and stiffness of muscles. Its effectiveness in children with cerebral palsy (CP), a population that typically displays changed muscle characteristics due to stiffness and other neuromuscular problems, is assessed in this review. The main studies, approaches, and conclusions are compiled to clarify the research and therapeutic uses of UE in the treatment of cerebral palsy. The assessment also identifies shortcomings and potential avenues for future study, highlighting the necessity of more extensive and standardised procedures. This comprehensive evaluation provides detailed information in tabular formats and goes deeper into diagnostic principles, therapeutic monitoring, and comparative advantages.

УЛЬТРАЗВУКОВАЯ ЭЛАСТОГРАФИЯ МЫШЦ У ДЕТЕЙ С ДЕТСКИМ ЦЕРЕБРАЛЬНЫМ ПАРАЛИЧОМ

[1]Ахмедов Э.А.
[2]Юсупалиева Г.А.
[1,2]Ташкентский педиатрический медицинский институт
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Ультразвуковая эластография, детский церебральный паралич, мышечная ригидность, спастичность, детская визуализация.

ABSTRACT

Ультразвуковая эластография (УЭ) стала популярным неинвазивным методом визуализации для определения эластичности и ригидности мышц. В этом обзоре оценивается его эффективность у детей с церебральным параличом (ДЦП), у которых обычно наблюдаются изменения мышечных характеристик из-за скованности и других нервно-мышечных проблем. Основные исследования, подходы и выводы собраны воедино, чтобы прояснить исследовательское и терапевтическое применение

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UE в лечении церебрального паралича. Оценка также выявляет недостатки и потенциальные направления для будущих исследований, подчеркивая необходимость более обширных и стандартизированных процедур. Эта комплексная оценка предоставляет подробную информацию в табличном формате и углубляет изучение принципов диагностики, терапевтического мониторинга и сравнительных преимуществ.

SEREBRAL FALAJLI BOLALARDA MUSHAKLAR ULTRATOVUSH ELASTOGRAFIYASI

[1]Ahmedov E.A.
[2]Yusupalieva G.A.
[1,2]Toshkent Pediatriya Tibbiyot Instituti
https://doi.org/10.5281/zenodo.14555158

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Ultratovushli elastografiya, miya yarim palsi, mushaklarning qattiqligi, Spastiklik.

ABSTRACT

Ultratovushli elastografiya (UE) mushaklarning elastikligi va qattiqligini aniqlash uchun mashhur invaziv bo'lmagan tasvirlash usuliga aylandi. Ushbu sharh miya yarim palsi (miya yarim palsi) bo'lgan bolalarda uning samaradorligini baholaydi, ular odatda qattiqlik va boshqa nerv-mushak muammolari tufayli mushaklarning ishlashida o'zgarishlarga duch kelishadi. Miya falajini davolashda UE ning tadqiqot va terapevtik qo'llanilishini aniqlashtirish uchun asosiy tadqiqotlar, yondashuvlar va xulosalar birlashtirilgan. Baholash, shuningdek, kengroq va standartlashtirilgan protseduralar zarurligini ta'kidlab, kelajakdagi tadqiqotlar uchun kamchiliklar va potentsial yo'nalishlarni ochib beradi. Ushbu keng qamrovli baholash jadval formatida batafsil ma'lumot beradi va diagnostika, terapevtik monitoring va qiyosiy foyda tamoyillarini o'rganishni chuqurlashtiradi.

Introduction

Cerebral palsy (CP) is a group of permanent movement and posture disorders caused by non-progressive disturbances in the developing fetal or infant brain. It is the most common cause of physical disability in children, with an estimated prevalence of 2-3 per 1,000 live births globally. Spasticity, a hallmark of CP, leads to increased muscle stiffness and reduced elasticity, significantly impairing mobility and quality of life. Conventional diagnostic tools such as MRI, CT scans, and clinical scales like the Modified Ashworth Scale (MAS) provide limited insights into the real-time biomechanical properties of affected muscles. Ultrasound elastography (UE), including strain elastography and shear wave elastography (SWE), offers a non-invasive and dynamic approach to quantitatively evaluate muscle stiffness. Its portability, affordability, and ability to provide immediate results make it particularly appealing for

pediatric populations. This review explores the potential of UE as a diagnostic and monitoring tool for CP, highlighting its ability to complement traditional methods and enhance therapeutic outcomes.

Materials and Methods

A comprehensive search of peer-reviewed publications from databases including PubMed, Scopus, and Google Scholar was done for this review. These search phrases included "muscle stiffness," "ultrasound elastography," "cerebral palsy," and "paediatric spasticity." Research on the clinical and experimental uses of UE in paediatric populations with cerebral palsy (CP) that was published between 2010 and 2024 was given priority.

Inclusion and Exclusion Criteria

- **Inclusion:** Articles examining the use of UE for assessing muscle properties in children with CP, studies with robust methodologies, and those published in English.
- **Exclusion:** Studies involving adults, non-musculoskeletal applications, or insufficient methodological details.

Data Extraction

Key data points such as study design, participant demographics, elastography methods, outcomes, and limitations were extracted and synthesized. Results were summarized in both narrative and tabular formats for clarity.

Result and Discussion

Children with cerebral palsy may benefit greatly from using UE to distinguished between spastic and non-spastic muscles. Clinical measures such as MAS and elastographic data have been found to positively correlate in studies that use SWE.

Study	Methodology	Muscle Examined	Key Findings
Kalkman et al. (2018)	SWE	Gastrocnemius	Increased stiffness correlates with MAS scores
Chen et al. (2021)	SWE	Rectus femoris	Elasticity values differentiate spastic vs. non-spastic muscles
Park et al. (2015)	Strain Elastography	Biceps brachii	Reliable for identifying muscle fibrosis

These findings suggest that UE can serve as a reliable diagnostic adjunct for assessing muscle stiffness, offering quantitative insights that complement clinical evaluations.

Therapy Monitoring

UE has been increasingly used to monitor the effectiveness of various therapeutic interventions, such as botulinum toxin injections, physiotherapy,and selective dorsal thizotomy. For example, studies report a measurable decrease in muscle stiffness post-treatment, particularly in the gastrocnemius and rectus femoris muscle.

Therapy	Muscle Monitored	Pre-Treatment Stiffness (kPa)	Post-Treatment Stiffness (kPa)
Botulinum Toxin	Gastrocnemius	45 ± 5	30 ± 4
Physiotherapy	Rectus femoris	50 ± 7	40 ± 6

These quantitative changes underlie the utility of UE in tracking therapeutic progress, allowing clinicians to tailor interventions more effectively.

Comparative Analysis

Compared to MRI, UE offers significant advantages, including portability, lower cost, and the ability to perform dynamic assessments. Unlike static imaging techniques, UE can assess muscles in motion, providing functional insights. However, challenges remain, such as variability in operator technique and equipment settings.

Challenges and Limitations

The primary limitations of UE include the lack of standardized protocols for pediatric applications and the influence of external factors such as age, hydration status, and muscle size. Additionally small sample sizes in existing studies limit the generalizability of findings. Addressing these challenges will require collaborative efforts to establish consensus guidelines and expand research.

Conclusion

Ultrasound elastography represents a transformative tool for assessing and monitoring muscle stiffness in children with CP. Current evidence supports its clinical and research applications, but further efforts are needed to standardize protocols and validate findings across larger populations. Future advancements, such as the integration of AI for automated analysis and the development of portable devices, could significantly enhance its utility. By bridging gaps in diagnostic precision and therapy monitoring, UE has the potential to revolutionize CP management.

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