Review Article

Application of ultrasonography in diagnosis and treatment of children with congenital muscular torticollis

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Abstract

Congenital muscular torticollis (CMT) is a more common childcare disease, which belongs to muscle-skeletal system diseases, and is more common in newborns. The disease is mainly due to congenital contracture due to chest locks, which leads to asymmetric head and neck. For such diseases, clear diagnosis and treatment in the early days is an important way to improve the prognosis of children. Compared with X-ray film, CT, and MRI, ultrasound examination has the advantages of low examination cost, short time, and no exposure to radiation during the examination. Moreover, ultrasound examination can provide an objective basis for the clinical diagnosis and prognosis evaluation of CMT children. This article reviews the latest research progress of conventional ultrasound, color Doppler ultrasound, and ultrasound elastography in the clinical diagnosis of CMT children and assisting in the formulation of treatment plans.

Keywords: Children, congenital muscular torticollis, ultrasonography

Introduction

Torticollis can be divided into congenital muscular torticollis (CMT) and congenital skeletal torticollis. The former is a congenital deformity of the head and neck caused by the contracture of one side of the sternocleidomastoid muscle, which is quite common, while the latter is a torticollis caused by the deformity of the cervical vertebrae, which is less common.[1] CMT is mainly due to congenital unilateral fibrous contracture of the sternocleidomastoid muscle (most common in the middle and lower segments). In the initial stage of the disease, the texture is firm, and there are round and oval masses that may disappear within a few months. After the occurrence of fibrosis, the performance of muscle contracture is caused, resulting in asymmetric deformity of the head and neck. Some children also have the manifestations of thickening of the middle scalene and anterior scalene muscles, perimysial fibrosis, contracture of the affected side arterial sheath, intrathecal vascular contracture, and shortening of the length of the deep fascia. The head of the child deviates to the affected side and the mandible is turned to the unaffected side, which has a great adverse effect on the growth and development of the child. The disease is generally caused by sternocleidomastoid muscle injury, hematoma organization, and contracture due to abnormal fetal position, abnormal childbirth, birth injury, and other factors. With the increase in the age of the children, the changes in head and face deformities gradually occurred. Relevant studies have shown that the incidence of the disease is 0.3%–0.6%, with children as the main patient population, and there is no significant difference between male

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and female children.[2] The specific etiology of these diseases is not yet fully understood, but it is generally believed that children with dystocia and cesarean section have a higher incidence. Therefore, many people believe that the occurrence of the disease is mainly due to hematoma fibrosis, muscle damage, and swelling caused by birth trauma, which hinders the return of venous blood, and then occurs ischemic contracture. However, there is no clear evidence to support this theory. Most of the literature reports that neck ultrasonography should be the first choice for the clinical diagnosis of CMT.[3]

This article intends to describe the latest research progress of ultrasound in the clinical diagnosis of children with CMT and assist in the formulation of treatment plans. We searched for relevant articles in the Pubmed database using "Ultrasonography and Children and Congenital Muscular Torticollis" as our search strategy.

Conventional ultrasound

Ultrasound imaging scans the human body with ultrasonic sound beams and obtains images of internal organs by receiving and processing reflected signals. According to the ultrasound manifestations of the sternocleidomastoid muscle in children with CMT, it can be divided into four types, type 1: localized thickening of the sternocleidomastoid muscle on the lesion side, uneven or normal echo, and clear surrounding muscle texture; 2: lesion in the background of normal muscle texture, the lateral sternocleidomastoid muscle is diffuse and scattered with strong echoes; 3: the whole sternocleidomastoid muscle is chaotic and strong echoes, and the normal muscle texture disappears; 4: the whole sternocleidomastoid muscle shows strong echoes, and longitudinal ribbon hyperechoic, normal muscle texture disappears.[4] Among them, type 1 is more common clinically in the neck mass type CMT, and types 2–4 are clinically seen in the neck mass type, the neck muscle texture change type, no neck mass, and the neck muscle texture change type CMT. Hsu *et al*. divided the routine ultrasound sonographic manifestations of CMT children into three types, and the results of follow-up on the prognosis of different types were shown.[4] The clinical treatment time for children with type III is significantly longer than that of type I, and the degree of cervical muscle fibrosis in children with type III is more severe than that in children with type I and II CMT.[4] Other studies have confirmed this view.[5] The results of Wang *et al*. showed that the ultrasound examination of patients with neck masses in 0–1 year old showed abnormal results.[6] Most of them showed thickening of the middle and lower part of the sternocleidomastoid muscle, and a few showed internal abnormality of the sternocleidomastoid muscle. Homogeneous echo and the sensitivity and specificity of conventional ultrasonography in diagnosing cervical bulky CMT were 95.83% and 83.33%, respectively.[6] To sum up, conventional ultrasonography has more advantages in the diagnosis of children with cervical mass CMT and can play a certain role in the selection of treatment plans and prognosis judgment, which is worthy of clinical promotion.

Color Doppler ultrasound

Color Doppler ultrasound examination is the blood flow signal obtained in the related technology, after color coding, real-time superimposed on the two-dimensional ultrasound image to form a color Doppler ultrasound blood flow image. Therefore, color Doppler ultrasound examination not only has the advantages of two-dimensional ultrasound images but also can provide hemodynamic information. Wang *et al*. showed that color Doppler ultrasound showed different blood flow signals of the sternocleidomastoid muscle in CMT children with different stages and degrees of fibrosis.[6] Color Doppler ultrasound showed short rod-like and cord-like blood flow signals in the SCM muscle of the patient with early CMT (aged 1 year). This finding may be related to the rich capillary network within reactive granulation tissue during labor due to the elongation of SCM muscle fibers under a heavy load of external forces and gravity. In patients with advanced CMT (age ≥1 year), there is no obvious blood flow signal in the involved SCM, which may be related to the organization of granulation tissue, increased fibrosis, and reduced number of blood vessels. The current findings suggest that color Doppler findings can help determine the stage of the disease and the extent of fibrosis.[7] Wang *et al*. studied eight cases of SCM with diffuse hyperechoic signal and marked neck tilt on an early ultrasound. Significant muscle fibrosis was found during surgery in all patients.[8] This suggests that when ultrasound detects a diffuse increase or strip-like hyperechoic signal within SCM lesions without blood flow signals in the lesions, indicating significant fibrosis of SCM, surgery should be performed instead of rehabilitation; therefore, ultrasound can guide treatment decisions in CMT patients.[9]

In summary, the results of the above studies show that: (1) Color Doppler ultrasound can reflect the internal hemodynamic changes of CMT children. In the case of no obvious abnormalities in the muscle structure of the lesion site, it can detect the internal blood flow signal changes of the lesion site earlier, which is helpful for the early diagnosis of CMT; (2) Color Doppler ultrasound examination can evaluate the effect of rehabilitation treatment by observing the changes of blood flow signals in the diseased muscles of CMT children, which is helpful for clinicians to evaluate the prognosis of children in time, and prompt clinical adjustment of the treatment plan in time; (3) Color Doppler ultrasound can clearly show the sternocleidomastoid muscle and its surrounding anatomical structure in CMT children, and preliminarily judge the prognosis of children according to the strength of the blood flow signal. In summary, color Doppler ultrasound has more advantages in the diagnosis of CMT children than conventional ultrasound diagnosis, and it can initially judge the prognosis of children according to the strength of blood flow signal of the examination results and assist in the clinical formulation of treatment plans for children.

Elastography ultrasound

As a non-invasive examination, ultrasound has the advantages of short time and low price. Real-time elastography has been effectively used to assess muscle stiffness, and strain elastography is the most commonly used type of real-time elastography. Hard tissues are more resistant to compression response and have less stress, while soft tissues show greater stress. CMT is a common disease in infants, and according to clinical symptoms, it may manifest as a tilt of the head to one side, limitation in neck movement, or a palpable lump in the infant's neck. The diagnosis of the disease is not difficult, but there is a lack of an objective diagnostic basis, which makes it difficult for the identification of muscle bias and non-muscle. The previous study on the stiffness of the CMT patient's thoracic lock mastoid muscle was less involved. There has been a significant gap in literature regarding the comprehensive understanding of these biomechanical changes in CMT patients. Besides, and ultrasound elastic imaging shows the stiffness of the skin of the patient's chest lock. When the diagnosis of ultrasonic normal bimodal is uncertain, it is expected to provide a new auxiliary method for diagnosing and evaluating the treatment of CMT patients. Friedman *et al*. divided 17 non-inflammatory carotid bundles through an ultrasonic examination into three echoes: cystic, substantial (strong or weak), and mixed echo.[10] Lee *et al*. suggested using real-time ultrasonic elastic imaging techniques to measure the elasticity of the organization.[11] They discovered that the condition of the muscle tissue influences its potential for growth. The histological changes revealed that, in elastic imaging, the force exerted by the tissue varies with changes in deformation or displacement. Kwon *et al*. studied 50 patients with CMT and showed that total thickening of the sternocleidomastoid muscle and the palpable mass on the sternocleidomastoid muscle was stiffer than patients with restricted neck movement.[12]

Discussion

In the past clinical examination, doctors mainly made diagnoses based on their own clinical experience, lacking scientific and effective basis, and faced great difficulties in disease diagnosis and treatment. However, ultrasonography is an effective imaging examination method with no pain. The advantages of pain and non-trauma can make an early diagnosis of CMT, to provide a basis for the subsequent treatment of children, which has important clinical value. Ultrasonography has been used as a diagnostic tool and for guiding treatment decisions in CMT. While success rates can vary depending on individual cases, ultrasonography has shown positive outcomes in the evaluation and management of this condition.[13] Ultrasonography plays a crucial role in the diagnosis and management of CMT.[14] It demonstrates good diagnostic accuracy by visualizing the affected neck muscles, such as the sternocleidomastoid muscle, and identifying any abnormalities or asymmetries, thereby confirming the diagnosis.[15] Additionally, it provides real-time imaging, enabling physicians to guide treatment interventions, such as stretching exercises or botulinum toxin injections, by visualizing the muscle. This facilitates accurate placement of injections and assessment of therapeutic maneuvers, leading to improved treatment outcomes. Ultrasonography also allows for monitoring treatment progress by comparing images taken before and during therapy, and evaluating changes in muscle length, thickness, and symmetry. This enables healthcare professionals to make necessary adjustments in treatment plans and optimize therapy to achieve better outcomes. Moreover, ultrasonography is non-invasive and safe, avoiding exposure to ionizing radiation, making it preferred, especially in pediatric populations where minimizing radiation is crucial. It is worth noting that while ultrasonography plays a valuable role in the diagnosis and management of CMT, it is often used in conjunction with other clinical assessments, such as physical examination and medical history, to form a comprehensive understanding of the condition and guide treatment decisions. In conclusion, ultrasonography has shown positive outcomes and contributes to the successful evaluation and management of CMT. It aids in diagnosing the condition, guiding treatment interventions, monitoring progress, and ensuring patient safety. Continued research and advancements in ultrasound technology may further enhance its capabilities in assessing and treating CMT, leading to even better success rates and outcomes for patients.

The results of this study show that through two-dimensional and color Doppler ultrasound examination, all aspects of CMT can be understood, which provides great value for the treatment of the disease. In children with CMT, ultrasound images showed that one side of the sternocleidomastoid muscle was prism enlarged, and there was a mass echo inside. Comparing the normal sternocleidomastoid muscle can show obvious differences and characteristics to the patient with CMT. In the ultrasound examination, if the result shows that the sternocleidomastoid muscle has significantly enhanced echo, it indicates that the child has fibrosis changes, and surgical methods should be taken in time to ensure the timeliness of treatment. For children who need surgical treatment, an ultrasound examination before surgery can fully understand the contracture of the sternocleidomastoid muscle in children and then formulate a more accurate and reasonable surgical treatment plan. Two-dimensional and color Doppler ultrasound has high clinical value in the diagnosis and treatment of CMT. It can accurately differentiate and diagnose the types of masses, and dynamically observe and evaluate the therapeutic effect. In the examination, we should also pay attention to the accuracy of the operation and be careful when judging the results. Combined with the specific clinical manifestations of children, we can get more accurate and reliable examination results.

The field of ultrasonography is continually evolving, and there are several future directions and potential advancements that hold promise for enhancing its application in diagnosing and treating CMT. (1) Advanced Imaging Techniques: Ongoing research aims to develop advanced imaging techniques that can provide more detailed information about the affected neck muscles in CMT. This includes advancements in high-resolution ultrasound imaging, three-dimensional (3D) ultrasound, and elastography, which can assess muscle stiffness and elasticity. These techniques may offer improved visualization and characterization of muscle pathology, aiding in more precise diagnosis and treatment planning. (2) Quantitative Assessment: Future advancements may focus on developing quantitative ultrasound techniques that enable objective measurements of muscle properties, such as muscle tone, stiffness, and contractility. Quantitative assessment could provide valuable insights into the severity of muscle involvement, help monitor treatment progress objectively, and assist in tailoring therapy to individual patients' needs. (3) Ultrasound-Guided Interventions: As technology advances, ultrasound-guided interventions for CMT may become more sophisticated. This includes the use of real-time ultrasound imaging to guide precise needle placement for botulinum toxin injections or other therapeutic procedures. Additionally, the integration of ultrasound with other modalities, such as electromyography, may enhance the accuracy and effectiveness of interventions. (4) Artificial Intelligence and Automation: The application of AI and automation in ultrasound imaging holds potential for improving diagnostic accuracy and efficiency. AI algorithms can assist in automating muscle measurements, identifying specific muscle patterns associated with torticollis, and even aiding in the diagnosis by analyzing ultrasound images. These advancements have the potential to streamline the diagnostic process and enhance the overall effectiveness of ultrasonography in CMT. (5) Multimodal Imaging Integration: Combining ultrasound with other imaging modalities, such as magnetic resonance imaging (MRI) or computed tomography (CT), may provide a comprehensive assessment of CMT. This multimodal approach can offer complementary information about muscle structure, function, and potential underlying causes, leading to more informed treatment decisions and improved outcomes.

In conclusion, the future of ultrasonography in diagnosing and treating CMT holds great promise. Advanced imaging techniques, quantitative assessment methods, ultrasound-guided interventions, AI and automation, and multimodal imaging integration are all areas of active research and development. These future directions have the potential to further enhance the accuracy, effectiveness, and personalized approach to diagnosing and treating CMT, ultimately improving patient outcomes.

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Conflicts of interest

There are no conflicts of interest.

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