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Research Article

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Development of Researches on Cranial Cavity Measuring Methods

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ABSTRACT

As the medical industry prospers, researches on human brain have progressed significantly. Cranial cavity, formed by bones of cerebral cranium, contains the central nerve system that controls and adjusts all physiological activities of human body such as cerebrum, cerebellum and medulla oblongata. The method of measuring brain concerns the diagnosis and treatment of brain diseases. This paper presented several methods of measuring brain and discussed its development by focusing on the MRI-based measurement of children's brain so as to provide reference for future progress and advancement of the brain measuring methods.

Key words: brain, measuring methods, MRI

INTRODUCTION

As one grows older, his cranial cavity changes. During the process from a newborn to a centenarian, one's brain changes as well as his skulls, leading to changes of the radial line, included angle, area, volume and brain tissues of the cranial cavity. And children witness the most significant such changes which results from many diseases, namely intracranial atrophic lesion such as generalized encephalomalacia, encephalatrophy or ceberal dysplasia and microcephalus. For recent years, with advances in medical technology, researches on cranial cavity measurement have made significant progress in this field.

RESEARCHES ON THE ADULT CRANIAL CAVITY MEASUREMENT

1. The cranial cavity measuring method based on autopsy

Many Chinese and foreign scholars [1], [2], [3], have researched the measurement of the cranial cavity volume via relevant parameters of the cavity with corpse as the object from the early stage. However, the researchers are limited in their achievements in that external measurement usually adopted, mostly linear one except the measurement of the cranium perimeter, is only for external cranium radial line while the internal cranium radial lines can only be obtained by estimation and calculation. Researches on corpse skulls mainly focus on the measurement of the weight of cranium and the volume of cranial cavity. Scholars like Wang Haijie [4] found significant differences in the cranium weight of women and men through measuring 100 skulls unearthed in Northeast China. There are a lot of ways to measure the cranial cavity volume based on autopsy. Conventional ones are measurement by blocking holes in the cranial cavity and filling medium into cavity or filling water into the rubber ball put in the cranium. But Ding Shihai [3] thought these conventional methods might lead to many errors. And the method of filling mercury by latex ball can get relatively precise data, but the procedures are too complicated. The current researches based on autopsy cannot meet the demand of researchers, while the application of imaging technology provides a more convenient way for measurement of the cranial cavity.

2. Researches on the cranial cavity measurement by the ordinary X-ray plain film

The X-ray diagnosis of central nervous system is based on the plain film of head, and the volume of the cranial cavity is essential for the diagnosis of brain disease. Therefore, the measurement of all radial lines related to the

cranial cavity volume is an important content of brain X-ray examination. Many Chinese scholars used X-ray to measure all radial lines and arc length that are closely related to the cranial cavity volume [5], [6], [7], [8], [9]. Li Ren-centered scholars[10] screened several radial lines or arcs outside the cranium that were easy to measure by stepwise regression analysis to calculate the volume of the cranial cavity and create the stepwise regression equation for the cavity volume. Fang Xiangdong[11] used X-ray to measure Tibetan adults' head and sella turcica to get the size and shape, and compared them to that of Han people. However, despite its critical role in the cranial cavity measurement, the X-ray plain film is gradually replaced by CT and MRI with higher resolution ratio owing to its definition and contrast ratio. As a result, CT and MRI realize the viviperception.

3. Researches on the CT-based cranial cavity measurement

As the conventional skull measuring method is not applicable to the measurement of a large number of living bodies, scholars including Li Haiyan [12] discussed to measure the weight of the prefrontal, parietal and occipital largely and quickly on the computer based on the CT image of healthy people and self-compiled calculation program so as to realize the measurement of different parts in one image and the same part in different images. Owing to the anomaly of human organs and tissues, the complexity of anatomical structure and difference of different people, Li Chuanfu-centered scholars [13] used anatomic and imaging knowledge based on the brain CT to propose an automated segmentation algorithm for the structure inside the cranial cavity based on sequence brain CT concerning image morphology and the continuity of the cranial cavity structure, providing advantages for the computer automation quantitative analysis of the CT-based cranial cavity volume. Besides, some scholars, in line with the methods proposed by Vassilouthis [15] and Mohr [16], measured the ventriculocranial ratio (VCR) of paracele of 422 Chinese healthy adults and put forward the normal range of the VCR value, providing an objective quantitative index to judge the size of paracele.

4. Researches on the MRI-based cranial cavity measurement

Owing the complicated structure inside the cranial cavity, disease of this part will seriously affect people's health. Thus, diagnosis of cranial cavity disease is one of focuses of medical practitioners. As early as 1990s, Cao Zhihui [17] measured and analyzed the radial lines of the cranial cavity of about 100 healthy adults with magnetic resonance imaging (MRI) technology, whose values provided data for future researches. Geng Daoying(2000) used MRI technology to measure parameters like the volume of cranial cavity of 200 healthy people aged from 5 to 89, conducted qualitative analysis of cavity parameters under MRI and discussed the clinical application value. To find the way to examine the basilar invagination by MRI, Xing Chunli(2004) examined the craniocervical junctions of over 100 people by MRI, built the standard of normal MRI of the angle of cranial base and the junction for reference and discussed the cause for basilar invagination and merits and demerits of MRI examination for such disease [18]. Cao Zhihuim [19] measured and analyzed the normal structure radial lines of the cranial cavity of 160 adults by MRI scanning, and the line values collected provided fundamental data for diagnosis of the cranial cavity disease by MRI.

RESEARCHES ON MRI-BASED MEASUREMENT OF CHILDREN'S CRANIAL CAVITY

As early as 1990s, scholars started to measure children's cranial cavity and study the characteristics with ordinary measuring instrument. For example, Wang Huiyong(1990) used the spreading caliper to measure the cranium of children of ethnic minorities in the western part of Guangdong province [20]. Yu yu(1991) measured the brain of newborns in Jiujiang city, Jiangxi province [21]. Zhang Wenxue(1994) used the anthropometer to measure the heads of healthy children in Xinxiang city, Henan province and analyzed the data [22]. In the 21st century, methods adopted by scholars tend to be standardized and diversified. Li Liqun(2008) measured over 700 children's heads in Baoshan district of Shanghai and analyzed the result with statistics to study the growing features of baby's head circumference [23]. Hou Binlan(2010) studied the growing features of head circumference of children aged from 3 to 6 by comparing the head circumference of nearly 800 children in Chenzhou city of Hunan province with the national child growing standard[24]. Wang Ping(2005) scanned some children's cranial cavity with spiral CT and got relatively clear images with several groups of parameters[25].

Children cannot describe clearly their cranial cavity disease or stay quietly, bringing big trouble to doctors in terms of the diagnosis. For recent years, many scholars studied the MRI-based measuring method of children's cranial cavity from several aspects. Chen Chuanming(2011) measured and studied the structure of the cranial cavity of over 500 children below 2 years old by MRI and obtained the normal value of all parameters of children's heads. The result offered the data helpful to evaluate children's brain development and enriched scholars' knowledge of children's cranial cavity structure. He Qiang(2011) analyzed the MRI scanning result of over 50 children below 3 years old and discussed the signal characteristics of T1WI and T2WI in different conditions such as hypoxic-ischemic encephalopathy of month-year-old babies, preemies and newborns. To further analyze the value of children cranial cavity MRI scanning technology in medical diagnosis and provide more reliable data for clinical diagnosis, Fan Xianmiao(2013) examined the cranial cavity of nearly 60 children via 1.5T superconducting MRI

scanner and discussed the T1WI and T2WI signal features, the cranial cavity structure characteristics and various diseases of children aged one month, two months to one year and one year to three years.

MRI inspecting technology can be used to examine the features of children's cranial cavity structure. From the current researches at home and broad, it can be inferred that the normal value of the cavity structure is usually for adults while the anatomic value of children's cranial cavity structure still lacks a unified standard, leading to troubles for clinical and imaging diagnosis. Without radiation, MRI can be adopted to scan children's cranial cavity for statistical researches. As for the brain development, children gain the fastest speed. The mass of brain of a newborn is 370g. Then the number becomes twice for half-a-year-old children and three times for two-year-old children. And the brain mass of seven-year-old children equals to that of an adult.

MRI-BASED RESEARCHES ON THE BRAIN OF CHIARI MALFORMATION PATIENTS

Chiari malformation is a disease featuring cerebellum tonsillar herniation. There are three types of such disease with I-type as the main one. Chiari malformation I (CMI) features cerebellum tonsillar herniating into the spinal canal [26], [27], [28], [29], [30] which can be classified into congenital and acquired one in terms of causes [28], [29]. The causes for this disease are too complicated to be figured out clearly till now [28]. The advances in medical imaging technology, especially its application in the diagnosis of MRI-based CMI brings both great convenience to CMI clinical diagnosis and benefits to patients. MRI-based measuring technology can identify the sick part of CMI to further know the pathogenesis so as to avoid many clinical misdiagnosis and misjudgment that often occurred before.

Based on the previous materials and researches, some scholars analyzed comprehensively MRI-based researches on CMI and summarized the pathogenesis[31]. Li Jun(2010) studied the MRI images and clinical manifestation of 10 confirmed CMI patients from 2008 to 2009 and discussed the value of MRI in CMI diagnosis[32]. Also, some scholars, taking over 200 CMI patients as the example, measured the areas of CMI patients' brain above and below the tentorium and analyzed the pathogenesis via MRI[33]. Zheng Xiaofeng(2000) figured out the characteristics of the brain of CMI patients via MRI and made preliminary analysis of the pathogenesi[34].

METHOD OF MEASURING HIPPOCAMPUS VOLUME BASED ON MRI IMAGING

The unique structure of hippocampus makes it a hot issue in medical researchers, especially in physiology, pharmacology, anatomy and psychology. However, owing to limited research methods and scientific technological level, the previous researches could only analyze the anatomic result and sections of cranial cavity of corpses to get data or information of the structural characteristics of hippocampus. And the data could not meet the demand of clinical diagnosis and scientific researches. As the computer technology and digital imaging technology develop, clinical researches on the measurement of hippocampus volume through imaging technology like MRI keep emerging [35], [36]. With the purpose of more precise hippocampus volume, scholars created various manual [34] and automated measuring methods[37],[38]. In addition, the fast developing brain morphology analysis method has been applied to the measurement of hippocampus volume [39].

CONCLUSION

Among diversified cranial cavity measuring methods, magnetic resonance imaging (MRI), as a new imaging technology for diagnosis and therapy without wounds or radioactive injures, develops rapidly for recent years with increasingly sophisticated technologies and extensive clinical application. To some extent, MRI has exceeded CT to be the first choice of imaging examination of the nervous system. With advancement and innovations of technologies, the brain measuring methods will become more diversified to provide more accurate data for the diagnosis of various brain diseases.

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