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PROBLEMS AND PERSPECTIVES OF VISUAL METHODS APPLICATION FOR DIAGNOSIS OF INFANTILE HIP JOINT PATHOLOGY

The most common methods of diagnosis of hip joint pathology in children - radiographic and ultrasonic are considered. Typical diagnostic images are analyzed, major drawbacks are revealed, including limited range of reproducible levels of brightness, low contrast and image sharpness levels, as well as high level of noise.

Key words: *hip joint, radiographic image, ultrasonic image, sharpness, contrast, noise, speckle noise.*

Introduction

Number of anomalies of development and diseases of hip joints in children, such as: congenital dislocations, subluxations, dysplasia, «coxa vara», «coxa valga» pathologies, etc., remains significant. According to different sources, a number of dysplasia cases per 1000 children is about 15, the number of congenital hip dislocations per 1000 children - 5 - 7 [1, 2]. Correct and timely diagnosis followed by effective treatment, besides clinical examination of the patient, depends on reliable information obtained by the methods of visual observation. At the early stages of the disease it is much more easier to perform treatment, it enables in greater part of cases to achieve complete recovery without any complications. Lack of proper diagnosis and proper treatment leads eventually to the development of serious complications and sometimes disability. Therefore, development of new diagnostic techniques and devices is the task of paramount importance aimed at early diagnosis of hip joint pathology. Expanditures for the development of diagnostic methods and tools are significantly less than the cost of prolonged treatment and state subsidies for disabled.

Analysis of the latest sources

Among the available methods of diagnosis the most widely spread are: - X-ray and ultrasound (D) diagnostics. Other types of examination - magnetic resonance tomography and computer-based tomography are too expensive and inaccessible, that is why, they are rarely used for diagnosis of these pathologies in children [1 - 3]. Today, in medical institutions of Ukraine medical examination is often performed using on obsolete, outdated equipment, that makes the process of setting the correct diagnosis rather complicated. Positive experience is the organization of orthopedic and trauma services in Western Europe and the United States, where mandatory screening test for all children under the age of 3 months is performed , using ultrasonic diagnostic equipment. Radiographic examination is fundamental and obligatory method for dysplasia diagnosis, subluxations , congenital hip dislocation and other diseases of hip joints in children. The principle of the survey is to obtain the image projection of the joints on the horizontal plane for further analysis. There exists numerous schemes for determination of the correct position of bones forming the hip joint using roentgenogram. The most common are Hilhenrayner - Erlakher and Ombredan – Perkins schemes, their maim objective is to determine the length of lines and angles between these lines, passing across specific points. An important feature of dysplasia in the picture is late appearance of ossification nuclei of heads of femur. Using the data obtained the diagnosis is set and treatment is prescribed [3].

The aim of research

The aim of research is to review the methods of visual diagnosis of hip joint pathology, commonly used in practice, and analysis of their information content.

Materials and methods of research

X-ray examination method is used as a means of monitoring the adequacy of therapeutic measures. Reliability of data depends on the correct X-ray technology - the correct position of the pelvis during the shooting and the direction of the central beam. While assessing the correctness of the course of the central beam and the correct position of the pelvic method of control parallels construction and method of control arcof obturator foramen construction are used. During X-ray anatomic evaluation of hip joints

all the discrepancies of projection should be taken into account[4]. Undeniable advantages of radiographic analysis is high accuracy as compared with ultrasonic examination. But at the same time given diagnosis also has significant disadvantage - high degree of exposure to harmful X-ray beams, which complicates the usage of this method for the diagnosis of children under the age of 1 month and also prevents the re-examination if necessary, since one X-ray examination of hip joints in children is performed at load of 0.4 mSv, and permissible annual dose of radiation load is 1 mSv. That is, doctor- orthopedist can to perform radiographic examination not more than two times, sometimes it is not sufficient, and taking into account that other possible diseases of internal organs and bone fractures also require urgent radiographic examination, the number of investigations may be even less. When using film X-ray machine, due to the sensitivity of film to the impact of different mechanical forces, defects may appear, which complicate the interpretation of images [5]. Therefore, obtaining of maximum possible amount of information from one snapshot is a priority. Ultrasonic investigation of hip joints is performed using linear sensor with frequency of 5.0 or 7.5 MHz. Optimally information images is obtained while placing the scanning plane parallelly to lumbar section of vertebral column and locating the sensor as closeas possible to the middle line of the joint in the projection of greater trochanter. At least two quality scannograms of each joint are performed for further comparison [6]. In the resulting image through the characteristic point of deposited Lines and angles are measured on the obtained image across characteristic points, as a result, the conclusion is made regarding the presence or absence of pathology. As compared with radiographic examination ultrasonic examination is harmless, that is why ultrasonic examination is recommended even for children aged 4 - 6 weeks. Ultrasonic diagnosis allows to evaluate joint pathology, but at the same time does not allow to determine exact geometrical parameters. Ultrasonic examination provides limited information about the mutual position of the joints, so its diagnostic value is limited. This type of diagnosis requires a qualified doctor, as non-correct sensor placement (non-observation of the requirements regarding patient placement, incorrect fixation, etc.) can lead to significant error . Besides, while measuring joint characteristic angles significant error can be made, which is predetermined by human factor and low-definition of the image [7]. But ultrasonic diagnosis can be used for treatment monitoring. For analysis typical images are selected, obtained by ultrasonic and X-ray apparatus, used at Vinnytcia municipal pediatric clinic number 1 . X-ray image of the hip joint obtained from the film X-ray apparatus, is shown in Fig. 1st. Brightness histogram clearly shows the limited range of reproducible brightness, due to imperfection of examination method (see Fig. 1b). This causes low contrast level - the most common drawback of roentgenograms, which complicates preliminary processing of such images and determination of geometrical parameters of investigated objects. For convenient perception two peaks must be present at image brightness histogram-object itself and background, brightness values difference should be significant. In the studied samples high density of intensities in the area of high shades of grey is noticeable, at the same time, low shades of grey are almost absent, characteristic peaks of density of object background intensities, so the details of image are merging with the background , that greatly complicates the detection of objects contours. An intensity image section, where additive noise is clearly seen, is shown that also complicates the interpretation of images (see Fig. 1 c).

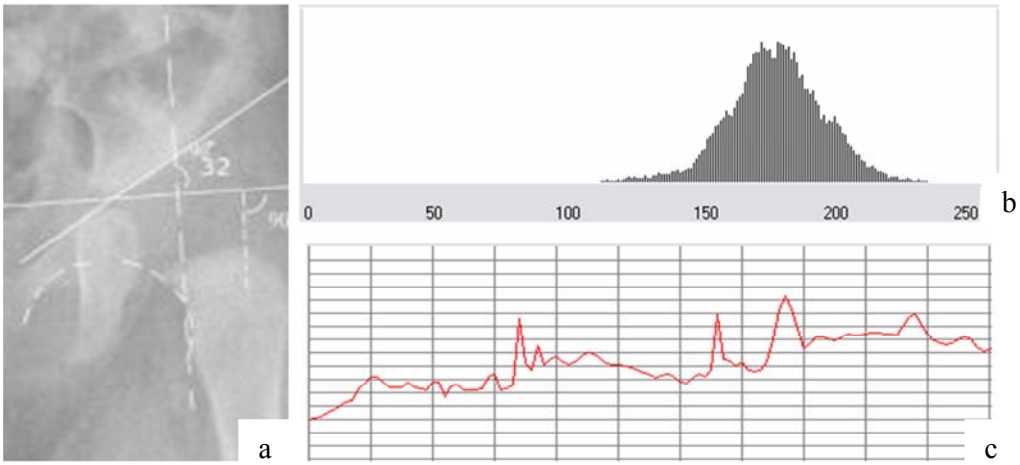

Fig. 1. Investigation of hip joint in analog X-ray apparatus:
a) typical image,
b) brightness histogram;
c) section by image intensity obtained from X-ray machine

Fig. 2 presents the image of the hip joint, obtained by ultrasonic device. Brightness histogram of such images has significant shift towards lower values of shades of grey, that complicates object localization in dark areas (see Fig. 2 b). Density peak of background intensities is clearly observed, while density peak of object intensities in the histogram is not noticeble. The cross section of hip joint image intensity is shown (see Fig. 2 a). It should be noted the presence of the characteristic speckle noise, which leads to visual "grain effect " of such images. The presence of the given noise is caused by the peculiarities of reflection of ultrasonic waves from investigated objects. Overall low level of sharpness that causes contours blurring effect is observed. In general the conclusion can be made about the blurring of such diagnostic image. Last drawback is most considerable, since for determination of geometrical parameters (angles α and β) it is necessary to mark specific points that are on the contours. Due to the fact that the child during examination is constantly in motion, and it is practically impossible to fix him , the image can be "blurred", indistinct.

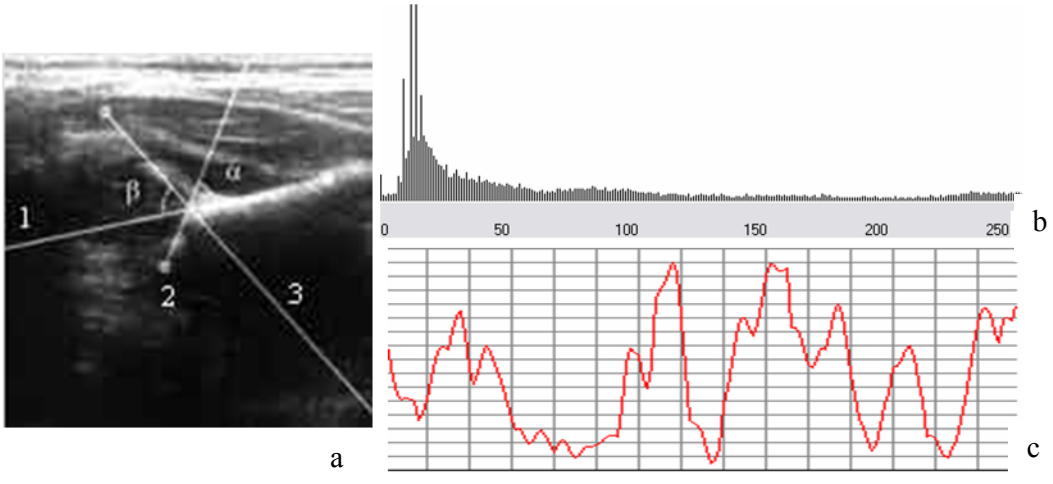

Fig. 2. Investigation of the hip joint by ultrasonic device:
a) typical image, b) histogram of image brightness;c) section of image intensity obtained by ultrasound machine

In the ultrasonic image the complete spectrum of shades of grey is presented , unlike X-ray image, which is characterized by a limited set of frequencies. However, ultrasonic image has much

higher noise level than the X-ray image , also it should be noted lowered sharpness of contour lines, as compared with the radiographic image. On the wholl X-ray image has better quality and higher diagnostic value, but harmfulness of X-rays impact on the human body, considerably limits the scope of the X-ray application. At the same time, ultrasonic diagnostics does not have harmful effect on human organism that allows to use this method for a wide range of tasks. Therefore, it should be noted substantial drawbacks of existing diagnostic ultrasonic images, as compared with X-ray images, as well as the prospects of digital methods of ultrasound images processing to improve their quality and information content.

Conclusions

There exist shortcomings concerning both X-ray and ultrasonic examination - low contrast and sharpness of initial image, and presence of noise. Since for setting of correct diagnosis error of angles measurement should not exceed 1, and the error of measurement of distances in the image - not more than 1 mm, then increasing the accuracy of these parameters determination is the priority in the development of diagnostic equipment. Usage of methods aimed at increase of sharpness and contrast of digital image will allow to improve the accuracy of the information parameters measurement without considerable expenditures for upgrading of the equipment and thus increase the reliability of diagnostic methods that further will become the main factor in setting the correct diagnosis. Since ultrasound diagnosis is less harmful than X-ray examination, and can be used repeatedly for different purposes, the creation of methods of noise suppression without significant blurring of details as well as methods of increasing sharpness and contrast of ultrasound images, which allow to obtain minimum difference of background and object brightness are priorities.

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