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Study of the anatomical character of nasolacrimal dust by spiral CT 3D reconstruction in children

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Abstract

• AIM: To measure the anatomical character of nasolacrimal dust by spiral CT 3D reconstruction in children.

• METHODS: The length of nasolacrimal dust and the angles between nasolacrimal dust and vertical plane, horizontal plane and coronal plane in 27 children(54 eyes) and 15 adults(30 eyes) were surveyed using spiral CT 3D reconstruction. While the length of nasolacrimal dust in 7 dead children(14 eyes) body were surveyed as comparison by anatomical method. The results were analyzed by software SPSS 13.0 statistically.

• RESULTS: The length of nasolacrimal dust was 10.06 ± 0.29mm in children and 11.51 ± 1.54mm in adults by spiral CT 3D reconstruction, as 9.95 ± 0.31mm in dead children body by anatomical method, with significant statistical difference between that of children and adults. The angles between nasolacrimal dust and vertical plane, horizontal plane and coronal plane in children were 7.96° ± 1.62°, 73.24° ± 6.75°, and 12.31° ± 2.03° respectively, while the corresponding angels in adults were 8.08° ± 0.63°, 72.69° ± 3.85° and 12.09° ± 1.21°. The difference between them had no statistical meaning.

• CONCLUSION: The anatomical data of children nasolacrimal dust obtained from spiral CT 3D reconstruction have important guidance to the therapy of nasolacrimal dust diseases in children.

• KEYWORDS: children ; nasolacrimal dust; spiral CT
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INTRODUCTION

Nasolacrimal duct, a narrow passage between orbit and nasal bone, is a complex anatomic position. It is also prone to damage by nasolacrimal surgery, especially in neonatal nasolacrimal disorders. Therefore, it is very important to understand the anatomic structure of neonatal nasolacrimal duct. The nasolacrimal duct in adult has been extensively studied, however, little is known about the neonatal nasolacrimal duct. The purpose of this paper is to measure the anatomic parameters of neonatal nasolacrimal duct by spiral CT and provide important guidance in treating such diseases.

SUBJECTS AND METHODS

Subjects The study includes 27 children (15 boys and 12 girls) who were examined by spiral CT in Shenzhen Children's Hospital between 2001 and 2005. The age of children ranged from 3 to 12 months, with a mean age of 6.8 months. None of these children had nasolacrimal diseases. Fifteen adult patients (5 males and 10 females) without nasolacrimal disease from the First Affiliated Hospital of Jinan University was also evaluated using spiral CT. The age ranged from 23 to 46 years old, with a mean age of 38 years old. The 7 head of dead children body (3 boys and 4 girls) preserved from the Department of Human Anatomy of Jinan University Medical College were also examined using the same technique. The age of these children was between 3 and 8 months, with a mean age of 5.2 months.

Methods of Examination Bilateral lacrimal duct was scanned using the double spiral CT (GE Hispeed NX/I, General Electricity Company, USA). Parameters of scanning: voltage-120kV, current-150mA, layer thickness-2mm, reconstruction-1mm, scanning time: per cycle-0.5s, scanning position: axial and coronary scanning, scanning range: from superior orbit rim to lower margin of palatum durum for axial scanning, from forehead to occipital process for coronary scanning. All images of scanning were entered into the imagework platform. Bone nasolacrimal duct was 3-dimensionally reconstructed according to the parameters. The length was evaluated and the projection angle was measured between the duct and median vertical plane, horizontal plane and coronary plane. The head of dead child was sawn along the superior supraorbital ridge, and removed the scalp, then removed all soft issues along front median line and external wall of both nasal cavity and cavity of sinus maxillaris. The bone material and structure of nasolacrimal duct was well preserved throughout the

processing. The constitution of nasolacrimal duct and surrounding structure was observed. The length of nasolacrimal duct was measured by compasses and slide calipers.

Statistical Analysis All data was statistically analyzed using the SPSS13.0 software.

RESULTS

The nasolacrimal duct was clearly observed through the 3-dimensional picture. The upper hole was roughly in the plane of inferior orbital rim, the lower hole lies in the side of inferior nasal duct. The length of nasolacrimal duct was considered as the lineal distance between the lowest point of upper nasolacrimal duct and the highest point of lower nasolacrimal duct. 1) The length of nasolacrimal duct in neonatal CT group was 10.06 ± 0.29mm. 2) The length of nasolacrimal duct in dead children group was 9.95 ± 0.31mm. 3) The length of nasolacrimal duct in adult CT group was 11.51 ± 1.54mm. After statistic analysis by Levene test, $F_{12} = 4.717$, $P = 0.033 < 0.05$, $F_{13} = 127.606$, $P = 0.000 < 0.05$, $F_{23} = 28.308$, $P = 0.000 < 0.05$, it is considered that the variance was different among these three parameters. After statistic analysis by independent sample t test, $t_{12} = 1.939$, $P = 0.07 > 0.05$, $t_{13} = -9.578$, $P = 0.000 < 0.05$, $t_{23} = -9.786$, $P = 0.000 > 0.05$, there was no significant difference in the length of nasolacrimal duct between CT scanning and anatomic measurement. However, there was significant difference in the length of nasolacrimal duct between children and adult.

In neonatal group, the angle between the axial of nasolacrimal duct and median vertical plane was 7.96° ± 1.62°; the angle between the axial of nasolacrimal duct and horizontal plane was 73.24° ± 6.75°; the angle between the axial of nasolacrimal duct and coronary plane was 12.31° ± 2.03°. In adult group, the angle between the axial of nasolacrimal duct and median vertical plane was 8.08° ± 0.63°; the angle between the axial of nasolacrimal duct and horizontal plane was 72.69° ± 3.85°; the angle between the axial of nasolacrimal duct and coronary plane was 12.09° ± 1.21°. After statistic analysis by Levene test, $F_1 = 0.431$, $P = 0.514 > 0.05$, $F_2 = 3.264$, $P = 0.74 > 0.05$, $F_3 = 2.250$, $P = 0.138 > 0.05$, it is considered that the variance was not different among these three parameters. After statistic analysis by independent sample t test, $t_1 = 0.89$, $P = 0.38 > 0.05$, $t_2 = 3.26$, $P = 0.74 > 0.05$, $t_3 = 0.88$, $P = 0.37 > 0.05$, we can assume that there were no significant differences as regards the three angles between adults and children.

DISCUSSION

Technical Advantage and Application of Spiral CT 3-dimensional Imaging Spiral CT 3-dimensional imaging is a novel technique to reconstruct stereotype images that can collect serial consecutive CT scanning data and was processed by computer software program. The method of reconstruction can convert 2-dimensional image into vivid and precise pictures which could be observed from different angles and different tissues can get their own auto-imaging with different colors. The spiral structure of various tissues could be therefore virtually visualized, and this technique has been named as "noninvasive stereotype anatomy". CT 3-dimensional reconstruction includes the reconstruction of bone, soft tissues and 3-dimensional artificial digital images of the surface of fabric endoscope-like cavity. With the application of CT 3-dimensional reconstruction technique, the anatomic morphology and adjacent relationship of human organs could be vivid and easily understood. This method was free of limitation of anatomic donor and process and can easily measure various parameters of human anatomy. The reconstructed 3-dimensional imaging has good stereotype and teaching purpose, and is very convenient for vivid education. This method can provide the medical student with more vivid and sensible understanding of human anatomic structure and can be widely applied in the field of basic and clinical teaching[1]. The clinical experience has shown that appropriate scanning parameter must be determined in order to get better reconstruction imaging. The volume data obtained through consecutive spiral CT scanning is the basis of 3-dimensional reconstruction. In order to get ideal volume data, the scanning layer thickness, thread pitch, and scanning field should be as small as possible. The voltage and current should be as high as possible. This study choose the following parameters: tube voltage-120kV, current-150mA, layer thickness-2mm. The target organ can be scanned at one time according to the purpose of examination. Clear, stereotype and vivid 3-dimensional anatomic imaging of nasolacrimal duct can be obtained from these data, and the precise spatial anatomic relationship of nasolacrimal duct and adjacent tissues can be vividly demonstrated. Groessl *et al* [2] scanned 71 adult patients and measured the anteroposterior diameter of nasolacrimal duct through three different planes and statistically analyzed the data. They found the mid-lower diameter of nasolacrimal duct of female patients was statistically lower than that of male patients. Groell *et al* [3] axially scanned the nasolacrimal duct of 147 healthy adults without nasolacrimal diseases and found that the length of nasolacrimal duct was 11.2 ± 2.6mm, which is roughly in agreement with our results: 11.51 ± 1.54mm. Our study found that the length of nasolacrimal duct in normal children examined by spiral CT 10.06 ± 0.29mm was not statistically different from that examined by anatomic method 9.95 ± 0.31mm. Meanwhile, spiral CT 3-dimensional reconstruction technique can also be applied in other subspecialties of medicine, such as the measurement of pediatric front rake of collum femoris[4]. It has been shown that the application of spiral CT 3-dimensional reconstruction technique in measuring nasolacrimal duct has been methodically accepted.

The Clinical Characteristic of Nasolacrimal Duct in Normal Baby Congenital nasolacrimal duct obstruction is common disorders of baby, with an incidence of 6%. The mainstream of therapy include high pressure syringe of nasolacrimal duct, probing and dacryocystorhinostomy. It has been reported that the successful rate of nasolacrimal duct surgery of children is high; however, there is still surgery failure rate of 8%. A major reason for that is the anatomic structure of baby was poorly understood, therefore, granuloma as a result of nasolacrimal duct damage often occur [5,6]. The same problem also existed in adult nasolacrimal surgery.

Therefore, it is a key step to recognize the anatomic relationship of nasolacrimal duct and precise positioning during operation. Our study showed that nasolacrimal duct and adjacent tissues can be vividly observed after 3-dimensional reconstruction. We also found that the length of baby nasolacrimal duct 10.06±0.29mm was shorter than that of adult nasolacrimal duct 11.51±1.54mm. It is probably that all parts of skull were significantly larger than those of children due to the developmental growth. However, there were no significant differences as to the three angles between adults and children. The results showed that the major change of nasolacrimal duct growth lies in it length, but not its pathway. Moreover, the length of adult nasolacrimal duct in our study is basically similar to that reported by other investigators. Therefore, understanding the anatomic feature of nasolacrimal duct could provide therapeutic guidance for children nasolacrimcal probing, such as choosing the probe length, probing depth and direction *et al*. It is also important for adult nasolacrimal duct surgery, such as dacryocystorhinostomy, laser nasolacrimoplasty and nasal endoscopic surgery *et al*. Only by doing so, unnecessary tissue damages could be avoided.

In the past, study of nasolacrimal duct often focused on the length and morphology, little is known about the spatial position of nasolacrimal duct. Steinkogler[7] studied adult nasolacrimal duct using dacryocystography and found that the posterior nasolacrimal duct stenosis was associated with the angle of nasolacrimal duct. This result suggests that anatomic abnormalities may be another reason for the development of nasolacrimal diseases and failure treatment. Previously, the direction of nasolacrimal duct was defined as backward, external and inferior, and is correspondent with the line from inner canthus angle to upper first molar. You *et al* [8] studied the anatomy of nasolacrimal duct and found that the direction of axial nasolacrimal duct is in parallel to the line from fossa sacci lacrimalis to the front point of attachment of ipsilateral concha nasalis inferior. Our study found that the axial length of nasolacrimal duct is similar to previous reports; therefore, provide better understanding the 3-dimensioinal position of nasolacrimal duct. It is of clinical importance for choosing angle and operating point such as nasolacrimal probing and nasal endoscopic dacryocystorhinostomy.

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婴幼儿鼻泪管螺旋 CT 三维重建及相关解剖学研究

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摘要

目的:应用螺旋 CT 三维重建技术探讨正常婴幼儿鼻泪管的解剖学特征。

方法:应用螺旋 CT 对 27 例(54 眼)正常婴幼儿和 15 例(30 眼)成人骨性鼻泪管三维重建后,测量骨性鼻泪管长度,鼻泪管长轴与正中矢状切面,水平切面,冠状切面投影的夹角等解剖学数据,同时用解剖学方法测量 7 例(14 眼)儿童尸头骨性鼻泪管长度作对照,应用 SPSS 13.0 软件进行统计学处理。

结果:螺旋 CT 三维重建测量婴幼儿骨性鼻泪管长度为 10.06±0.29mm,儿童尸头骨性鼻泪管长度为 9.95±0.31mm,成人骨性鼻泪管长度为 11.51±1.54mm,前两者之间的差异无统计学意义,而两者与成人鼻泪管长度之间的差异有统计学意义。婴幼儿鼻泪管长轴与正中矢状切面投影的夹角为 7.96°±1.62°,与水平切面投影的夹角为 73.24°±6.75°,与冠状切面投影的夹角为 12.31°±2.03°;成人鼻泪管长轴与正中矢状切面,水平切面,冠状切面投影的夹角分别为 8.08°±0.63°, 72.69°±3.85°, 12.09°±1.21°,两者之间无显著性差异。

结论:螺旋 CT 三维重建技术是测量婴幼儿鼻泪管解剖学数据的一种有效方法,所得解剖学数据对婴幼儿泪道疾病的手术治疗有重要的指导作用。

关键词:婴幼儿;鼻泪管;螺旋 CT