Short Communication

Distance, Depth and Puncture Angle for Cisterna Magna in Chinese Adults as Read from Magnetic Resonance Imaging

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Introduction

The cisterna magna is a space lying between the cerebellum and medulla oblongata that is important in collecting cerebral spinal fluid (CSF) in some patients with contraindication or the impossibility of lumbar puncture and in intrathecal administration medication infusion.[1,2] Knowledge of the anatomy of the cisterna magna, especially the key distance from skin to cisterna magna is necessary in safely performing cisternal puncture. Until now, specific anatomical measurements *in vivo* have not been reported in the medical literature. To provide this necessary reference information, we analyzed the depth from the skin to cisterna magna, the direction and site of cistern puncture in Chinese adult patients.

Methods

After obtaining IRB approval and written informed consent, this sampling survey included 449 adult patients (211 males and 238 females) who received an magnetic resonance imaging (MRI) examination of the head (Siemens NOVUS 1.5T) at Aviation General Hospital between April 2013 and September 2013. With a standard deviation (SD) of measurement results at 1.05 cm, from skin to the posterior wall of cisterna magna, the level of significance was set at 5% (two-sided analysis) with 90% power and an allowable error δ at 0.1 cm. Therefore, the required sample size for this study would be:

$N = (1.96 \times 1.05/0.1)^2 = 424.$

Patient consent was obtained from all patients prior to participation. Demographic data collected included: Gender, age, height, weight, body mass index (BMI), neck and head circumference, antero-posterior and bi-temporal diameters of head, birthplace, and ethnicity. The study was limited to adults who consented to participate. We excluded the patients who had undergone cervical or cranio-cerebral operations, who were diagnosed with Arnold–Chiari malformation, who were unable to stand unassisted, or whose MRI images were unclear.

Each patient was asked to take off his or her shoes prior to measuring height and weight. Neck and head circumference were measured using a soft measuring tape. Neck circumference was measured at the level of the cricoid cartilage, and head circumference was measured through the superciliary arch and external occipital protuberances. The antero-posterior and bi-temporal diameters of the head were measured by a sliding caliper.

A line was drawn across the following two points, one point is the midpoint of the posterior margin of foramen magnum and superior margin of posterior arch of atlas, the other point is gracile tubercle in medulla oblongata [Figure 1]. According to the line, the positions on the forehead were recorded, above glabella, glabella, between glabella and root of nose, below the root of nose [Figure 1]. Using an integral automatic centimeter ruler, the following measures were taken: The distance from skin to the posterior wall of cisterna magna and the depth of the cisterna magna, from the inner line of the posterior wall of cisterna magna to gracile tubercle.

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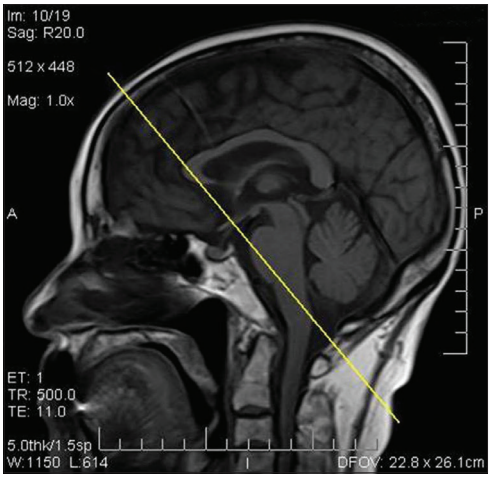

Figure 1: Abridged general view of cisternal puncture.

Continuous data were expressed as mean ± SD. The analysis of the correlation between the distances and the gender, age, neck circumference, BMI, antero-posterior and bi-temporal diameters of the head were performed using multivariate regression analysis. The differences in distances and depths between male and female were analyzed by independent sample *t*-test. Statistical significance was defined at $P < 0.05$. All analyses were performed using SPSS software (SPSS Inc., USA.) for windows (version 13.0).

Results

The demographic data of the 449 patients (211 males and 238 females) involved in our research are shown in Table 1. The source of origin of the subjects is shown in Table 2.

The distances from the skin to the posterior wall of cisterna magna are summarized in Table 3. The distance from skin to the posterior wall of cisterna magna is 5.50 ± 05 cm. The distance from the skin to the posterior wall of cisterna magna is significant statistical different between males and females ($P < 0.0001$). The depth of cisterna magna is 1.25 ± 0.24 cm, it was significant statistical different between males and females ($P < 0.0001$). The directions of puncture are shown in Figure 2, with the majority of patients requiring an approach above the eyebrow.

Table 4 shows the main results of the step-wise regression are shown below. The best correlation was found between the distance from the skin to the cisterna magna and gender according to the standardized coefficients.

Discussion

The cisterna magna occupies a large space in the brain where CSF can be collected, or medication administered for intrathecal infusion;[1,2] however, the distance from skin to the cistern and depth of cisterna magna varies by gender, weight and age. This study enrolled 449 patients in order to explore the anatomy of the cisterna magna in living patients. These data can provide useful information to safely effect cisternal puncture.

Table 1: Demographic data (mean ± SD)

Items	Male (n = 211)	Female (n = 238)	All patients (n = 449)	P
Age (years)	54.4 ± 14.6	54.1 ± 14.5	54.3 ± 14.5	0.828
Height (cm)	169.1 ± 6.62	157.7 ± 5.72	162 ± 8.38	<0.001
Weight (kg)	72.3 ± 12.3	61.0 ± 9.05	66.3 ± 12.1	<0.001
BMI (kg/m^2)	25.2 ± 3.45	24.5 ± 3.61	24.8 ± 3.54	0.051
Head circumference (cm)	56.9 ± 1.63	56.7 ± 1.98	55.7 ± 2.12	<0.001
Neck circumference (cm)	39.5 ± 2.80	35.7 ± 2.62	37.5 ± 3.30	<0.001
Antero-posterior diameter (cm)	19.3 ± 0.68	18.3 ± 0.64	18.8 ± 0.81	<0.001
Bi-temporal diameter (cm)	14.1 ± 0.87	13.4 ± 0.72	13.7 ± 0.86	<0.001

SD: Standard deviation; BMI: Body mass index.

Table 2: Birthplaces and nationalities of the subjects

	Number
Birth place	
Anhui province	15
Beijing municipality	121
Fujian province	2
Gansu province	2
Guangdong province	2
Guangxi Zhuang autonomous region	3
Guizhou province	2
Hebei province	72
Henan province	41
Heilongjiang province	24
Hubei province	14
Hunan province	8
Jiling province	8
Jiangsu province	13
Jiangxi province	4
Liaoning province	24
Inner Mongolia autonomous region	17
Shandong province	22
Shanxi province	7
Shaanxi province	15
Shanghai municipality	2
Sichuan province	10
Tianjing municipality	6
Xinjiang Uygur autonomous region	1
Zhejiang province	11
Chongqing municipality	2
Mongolia	1
Total	449
Nationalities	
Daur	1
Han	425
Hui	5
Man	8
Monggol	7
Tujia	1
Xibe	1
Zhuang	1
Total	449

Table 3: Measurements of cisterna magna distances (mean ± SD)

Items	Male (n = 211)	Female (n = 238)	P
Distances from skin to cisterna magna (cm)	6.10 ± 0.84	4.96 ± 0.91	<0.0001
Depth of cisterna magna (cm)	1.29 ± 0.24	1.21 ± 0.23	<0.0001

SD: Standard deviation.

Table 4: Partial correlation coefficients between distance from skin to cisterna magna and gender, age, neck circumference

Items	Coefficient	P
Constant	1.477	0.022
Gender	−0.708	<0.0001
Neck circumference	0.111	<0.0001
Age	0.017	<0.0001

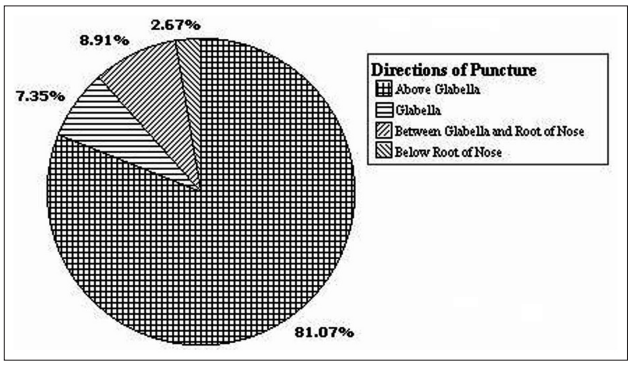

Figure 2: The puncture directions of cisterna magna. The best direction was through above the eyebrows was in 81.07% of the patients and through the eyebrows in 7.35%.

In this study, significant gender differences were seen in the distance from the skin to cisterna magna, this result is similar to Zhao *et al*.'s results.[3] The distance was filled in 6.10 cm in male, and the distance was filled in 4.96 cm in female. These results suggest that clinicians should take gender differences into account when performing this technique. On the other hand, gender differences were small in measuring the depth of the cisterna magna. The mean depth was 1.29 cm in males and 1.21 cm in females: This very small difference of 0.08 cm is not clinically significant.

The technique for puncture direction is very important. Serious complications such as laceration of the cerebellar artery by sub-occipital puncture of the cisterna magna, may ensue if the direction of the needle is inappropriate.[4,5] However, previous reports have discussed alternative approaches for cisternal puncture.[1,6,7] Our results show that the direction above the glabella was most reliable in the majority of the patients [Figure 2], it is different from Ward *et al*.[1] In this direction, the average depth of the cisterna magna was 1.25 cm, which was similar in both males and females.

Magnetic Resonance Imaging images were taken in the sagittal view while computed tomography views were read in cross-section. This may have resulted in some disparity between views. Additionally, patient measurements were taken with patients supine for radiological studies as compared with neck flexion in clinical work. Therefore, the depth from the skin to the cisterna magna might differ from radiological studies to the clinical setting.

Our results may be useful in assisting the physician in performing cisternal puncture safely and efficiently. To our knowledge, This study is the first *in vivo* anatomical study in human Chinese patients for the purpose of cisternal puncture. However, caution should always be exercised, as there are occasional patients whose cistern is located very superficially or very deep from the skin surface. In our study, the SD of the depth from the skin to cistern approached 1 cm (0.84 cm for males and 0.91 cm for females).

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