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A Clinical and Anatomical Study on the Localization of the Temporal Branch of the Facial Nerve Crossing the Zygomatic Arch

Estudio Clínico y Anatómico sobre la Localización del Ramo Temporal del Nervio Facial que Cruza el Arco Cigomático

Na-Shun Mengke[1]; Fei-fei Li[1]; Qian Zhang[2]; Chang Su[3]; Pu Chun[1]; Xi-da Ma[3]; Tao Qin[1]; Yan-yan Chi[1]; Sheng-bo Yu[1] & Hong-jin Sui[1]

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SUMMARY: To clarify the path of the temporal branch of facial nerve (TB) crossing the zygomatic arch (ZA). Eighteen fresh adult heads specimens were carefully dissected in the zygomatic region, with the location of TB as well as its number documented. The hierarchical relationship between the temporal branch and the soft tissue in this region was observed on 64 P45 plastinated slices. 1. TB crosses the ZA as type I (21.8 %), type II (50.0 %,), and type III (28.1 %) twigs. 2. At the level of the superior edge of the ZA, the average distance between the anterior trunk of TB and the anterior part of the auricle is 36.36±6.56 mm, for the posterior trunk is 25.59±5.29 mm. At the level of the inferior edge of the ZA, the average distance between the anterior trunk of TB and the anterior part of the auricle is 25.77±6.19 mm, for the posterior trunk is 19.16±4.71 mm. 3. The average length of ZA is 62.06±5.36 mm. TB crosses the inferior edge of the ZA at an average of 14.67±6.45 mm. TB crosses the superior edge of the ZA at an average of 9.08±4.54 mm. 4. At the level of the ZA, TB passes on the surface of the pericranium while below the SMAS. The TB obliquely crosses the middle 1/3 part of the superior margin of the ZA and the junction of the middle 1/3 part and the posterior 1/3 part of the inferior margin of the ZA below the SMAS while beyond the periosteum. It is suggested that this area should be avoided in clinical operation to avoid the injury of TB.

KEY WORDS: Temporal branch of facial nerve; Zygomatic arch; P45 sectional plastination technique.

INTRODUCTION

There are five branches of the facial nerve, among which the temporal branch (TB) is involved in innervating the mimetic muscle above the palpebral fissure. TB crosses the zygomatic arch (ZA) and runs in the temporal region, frontal region and supraorbital region as it ascends to innervate the frontalis muscle, orbicularis oculi muscle above eyelid fissure and corrugator supercilii muscle (Jiang *et al*., 2003). Facial nerve protection is involved in facial rejuvenation surgery, zygomatic surgery and skull base surgery through zygomatic arch approach, and several other surgical procedures. In this paper, the starting point, position, number of TB in ZA region and its relationship with soft tissue level were studied through fine anatomy of craniofacial specimens and the observation of P45 specimens.

MATERIAL AND METHOD

Anatomical observation of gross specimens. A total of 36 sides of frozen fresh adult craniofacial specimens (11 males and 7 females) were selected (Only 32 sides can be recognized). Cut the skin along the superior temporal line-anterior tragus-mandibular branch. Peel off the skin and subcutaneous fat from posterior to anterior side, and remain the eyebrow, lateral canthus and auricle. The location of zygomatic arch was determined through landmarks such as tragus, lateral canthus. The parotid sheath was opened and the parotid plexus of the facial nerve was carefully identified in the parotid tissue. The main trunk of the facial nerve was dissected and traced to the ZA area. The superficial layer of the zygomatic arch was stripped off so that the temporal branch was fully exposed (Vernier calipers with accuracy of 0.01 mm).

[1] Department of Anatomy, College of Basic Medicine, Dalian Medical University, Dalian 116044, Liaoning Province, China.
[2] The Second Hospitalof Dalian Medical University, Dalian 116044, Liaoning Province, China.
[3] The First Hospital of Dalian Medical University, Dalian 116044, Liaoning Province, China.

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Landmarks of cadaver. Number of branches of TB in ZA region (N); length of the zygomatic arch (LZA); horizontal distance between each branch of TB crossing the superior edge of ZA and the anterior edge of the external acoustic meatus (EAM, also be the posterior end of ZA) (SA); the horizontal distance between each branch of TB crossing the inferior edge of ZA and the anterior edge of the internal acoustic meatus (IA); the span of the TB at the superior edge of ZA (S0); the span of the temporal branch of the facial nerve at the lower edge of ZA (I0) (Fig.1).

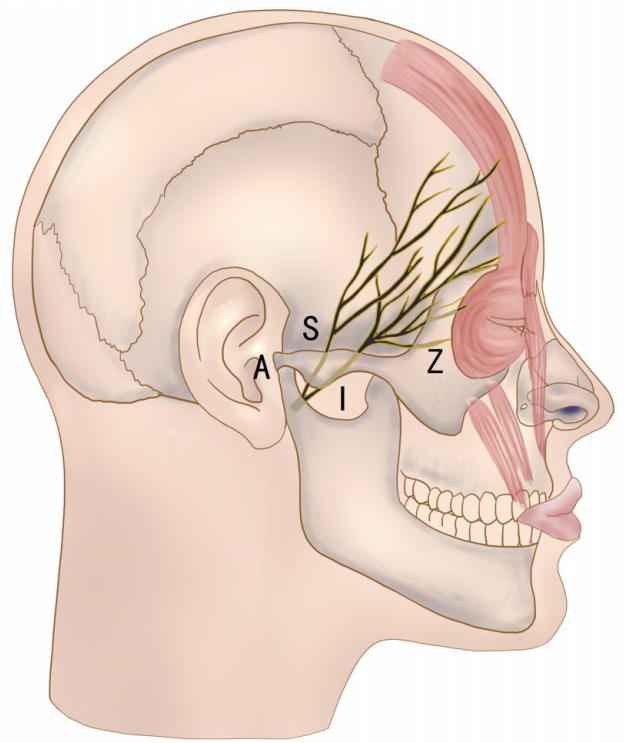

Fig. 1. Schematic diagram of the path of the temporal branch of the facial nerve (TB) crossing the zygomatic arch (ZA). The TB crosses the ZA obliquely upward from the front of the tragus. A, Z, S and I are the observation landmarks. Z: The anterior end of the ZA; A: The posterior end of ZA (anterior edge of external auditory meatus); S: The intersection of TB and superior edge of ZA; I: The intersection of TB and inferior edge of ZA.

P45 plastination slice technology. The Coronal P45 sections of 32 cases of the human Cephalo-facial specimen were observed and the anatomical characteristics of the hierarchical relationship between TB and the surrounding soft tissue in ZA region were analyzed and recorded. None of the specimens showed signs of traumatism or cancer. The experimental steps are as follows (Sui & Henry, 2007):

1. Slice: The specimens were frozen at -70 ºC for 2 weeks, embedded in the embedding box by polyurethane, frozen again at -70 ºC for 2 days and sliced with a high-speed band saw to a thickness of 3 mm.

2.Bleaching: Rinsed slices with cold water overnight and soaked in 5 % hydrogen peroxide overnight.

3.Dehydration: After the slice bleaching, the slices were precooled and then dehydrated in 85 % acetone at -25 ºC for 5 days, then placed in 90 % acetone at -15 ºC for 5 days, then degreased at room temperature and finally placed in 100 % acetone.

4.Vacuum impregnation: The slices were taken out from the acetone bath, clamped with a double glass plate, the slice infiltration mold was made, and the slices were filled with Hoffen polyester P45 (Dalian Hoffen Biotechnic Co., Ltd., Dalian, China). The mold filled with the infiltration and embedding material was placed vertically in the vacuum cabinet for impregnation at room temperature. The pressure was slowly reduced to 20, 10, 5 and 0 mmHg according to the bubble size and releasing rate. Keeping the pressure 0 mmHg until the bubbling stopped. The impregnation time lasted more than 8 hours.

5. Curing: After releasing the vacuum, check and remove the bubbles in the plate. Then the slices were put in a 40 ºC hot water bath and placed upright for 3 days. After curing, the slices were removed from the glass plate and properly covered with bonded plastic folia to provide protection.

6. Observation and photography: The slices were observed under a microscope and photos were taken with a Canon 7D camera (Canon Inc., Tokyo, Japan).

RESULTS

Number of temporal branches and their relative positions in the zygomatic arch region. In the ZA area, the occurrence of a single running TB (type I), two branches (type II), and three branches (type III) accounted for 21.8 % (seven sides), 50.0 % (16 sides), and 28.1 % (nine sides) of cases, respectively.

The ZA length was 62.96 ±5.52 mm from the anterior edge of the external acoustic meatus (EAM) to the angle of the frontal process and temporal process of the zygomatic bone. The average distance between the anterior branch of TB and the anterior edge of EAM measured at the superior margin of ZA was 36.36 ±6.56 mm, where as that at the inferior margin of ZA was 25.59 ±5.29 mm. The average distance between the posterior branch of TB and the ante-

rior edge of EAM measured at the superior margin of ZA was 25.77 ±6.19 mm, where as that at the inferior margin of ZA was 19.16±4.71 mm.

The average span of type II and type III TB was 14.01 mm at the upper margin and 9.13 mm at the lower margin of the ZA. Considering that the anterior edge of the EAM was 0 % and the front end of the ZA was100 %, the TB ran at intervals of 41.7 % / 58.2 % at the upper edge of the ZA and 31.1 % / 41.3 % at the lower edge of the ZA based on statistical analysis (Fig. 2).

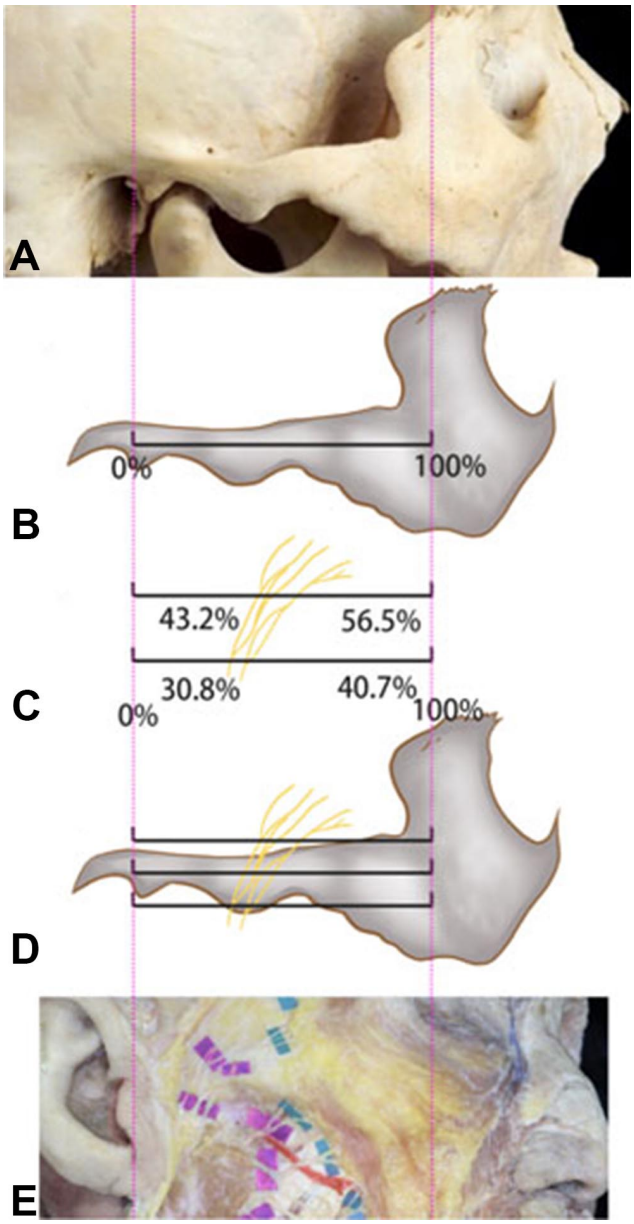

Fig. 2. Schematic diagram of the ratio of TB across ZA. A: zygomatic bone; B: proportion of ZA's schematic diagram; C: the proportion of temporal branches across ZA; D: the proportion of TB across ZA; E: gross anatomy

Hierarchy of the TB of the facial nerve in the ZA region. Multiple cross-sections of the TB of the facial nerve were observed in the coronal section of P45 in the medial and posterior ZA segments (Fig. 3). In the ZA region, TBs were observed between the lower superficial musculoaponeurotic system (SMAS) and the upper periosteum layers. The gross anatomical results were consistent with these results.

DISCUSSION

Number of branches of TB in the ZA region. Most previous studies suggest that the maximum range of the number of TBs in the ZA region is two to four; however, some previous reports have identify edit to be one to five. de Bonnecaze *et al*. (2015) dissected 24 Caucasian hemifacial specimens and found an average of 2.5 branches in the ZA. After dissecting the heads of the 18 Turks, statistical analysisin a study by Babakurban *et al*. (2010) revealed that a single TB crossing the ZA accounted for 14.3 %, two branches accounted for 57.1 %, and three branches accounted for 14.3 % of cases. Most cases had three branches, accounting for 80 % of all the cases. In summary, two or three TBs were more common in the ZA region than in the other regions, which were also confirmed by the results of this experiment.

Relative position of TB in the ZA region. In anatomical studies on the specific position of the TB at the ZA level, de Bonnecaze *et al*. (2015) proposed that the TB spans approximately 24.25 and 28.25 mm at the lower and upper edges of the ZA, respectively. Pujol-Olmo *et al*. (2020) measured the distance from the top of the EAM to the TB across the lower edge of the ZA as 3.21 ±0.05 mm. Poblete *et al*. (2015) observed that the distance between the EAM and posterior branch of the TB on the superior margin of the ZA was approximately 11.0-22.9 mm. The results obtained in previous experimental data were smaller than those obtained in the current experiment, which indicates that the span of TB in the ZA area was smaller and tended to run posteriorly in this experiment. Differences in data may be related to the number, freshness, and ethnic differences of the specimens.

The mean distance between the last branch at the upper edge of the ZA and the posterior end of the articular tubercle was 18.0 ±2.0 mm. The experimental data were consistent with the data intervals reported in the Chinese literature. These data sufficiently reflect the influence of ethnic differences on the course of the facial nerve and provide an indicator for clinicians to arrive at anatomical conclusions. However, this view requires further validation with more comparative data and statistical analyses in future studies.

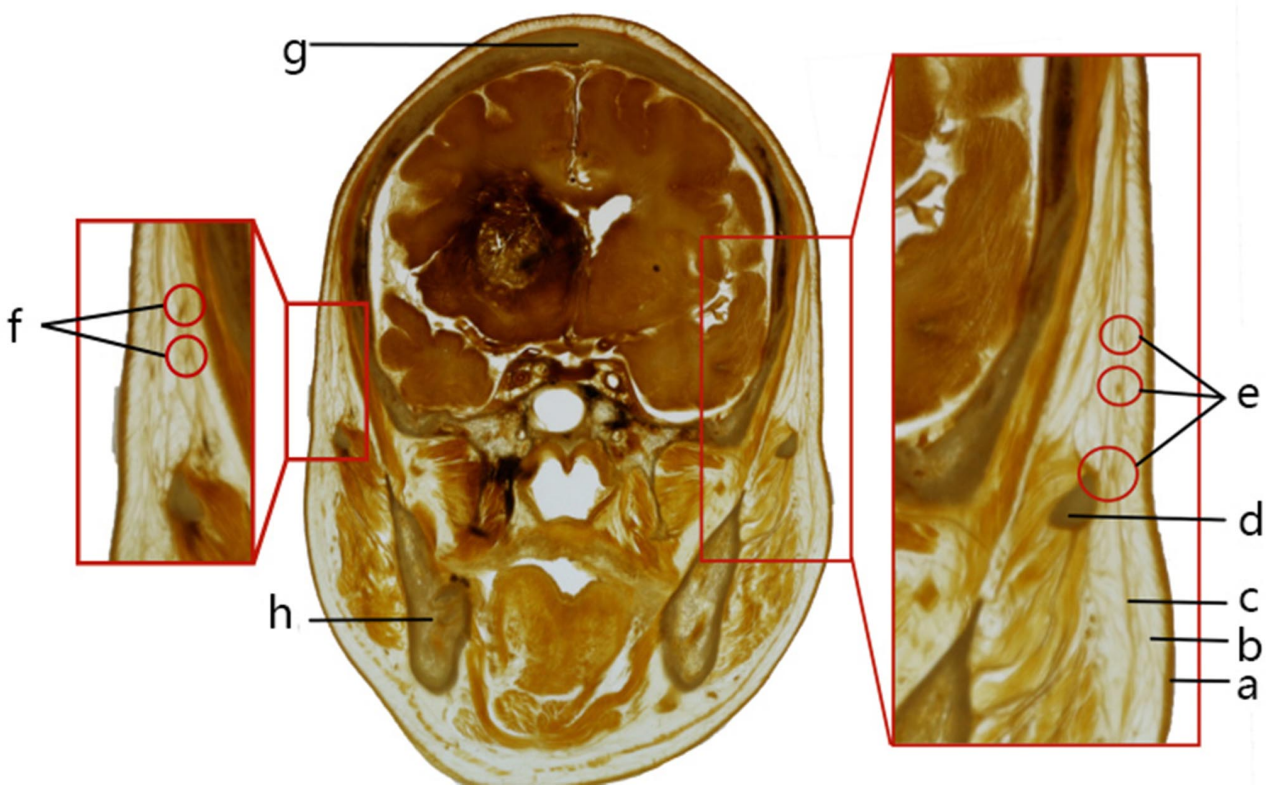

Fig. 3. Coronal P45 plastinated section of ZA (Mid-posterior part) and local magnification. According to experience, the cross section of blood vessel is usually a hollow circle while the nerve is usually a solid circle in sectional anatomy. Basing on the position of the coronal P45 plastinated section of ZA, it can be speculated that the solid circles are TB in this area, which indicates that TB run below the SMAS and beyond the periosteum in ZA area. a: skin layer; b: subcutaneous layer; c: Superficial Muscle-Aponeurotic System; d: ZA; e: TB of right face; f: TB of left face; g: skull; h: mandibular.

This study aimed to provide anatomical data suitable for clinical application. Considering the difficulty of directly utilizing specific data during a surgical procedure because of individual differences, we used proportion data to represent the position of the TB across the ZA in this study. Through further analysis of significant values in our results, we found that a relatively constant position of TB can be expressed as follows: at the superior margin of the ZA, the TB moves obliquely upward across the ZA in the medial section. At the inferior margin of the ZA, the TB runs through the junction of the medial and posterior ZA (near the EAM; Fig.4).

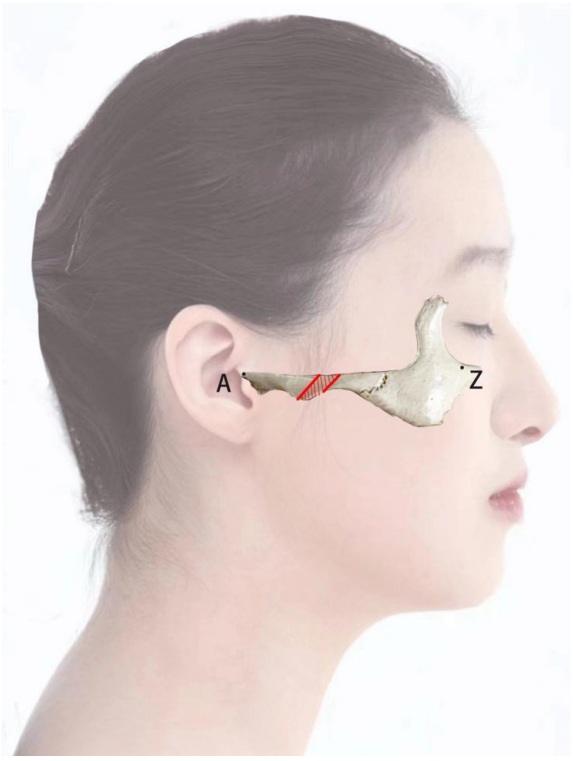

Fig. 4. Danger Zone of ZA. The TB obliquely crosses the middle 1/3 part of the superior margin of the ZA and the junction of the middle 1/3 part and the posterior 1/3 part of the inferior margin of the ZA. This area is dangerous during ZA-related surgery, in which doctors must pay more attention to avoid nerve damage.

Course of TB in the ZA region. Babakurban *et al*. (2010) reported that the TB crossed the ZA on the surface of the periosteum. The anterior and median one-third segments of the ZA have a thick fat pad as a buffer between the TB and periosteum (Elvan *et al*., 2017). Tayebi and Farahvash *et al*. (2013) observed that the TB ran between the SMAS and parotid masseter fascia in the ZA region (Meybodi *et al*., 2017). In this study, plastinated sections of coronal P45 were observed; TB was found to run close to the SMAS and above the periosteum in the ZA area. The P45 plastinated sectional specimen was dry, non-toxic, transparent, non-deformed, and easy to observe. In situ analysis has revealed the morphology of the internal anatomical structure of a section and its interrelationship (Sun *et al*., 2021). The obtained observational results are reliable and consistent with those of previous studies.

In the past, observations of the position of the TB across the ZA were limited due to the existent gross anatomical research methods; hence, they were not comprehensive enough, the course level was unclear, and detailed anatomical data to support it was absent. The ZA region is considered one of the most vulnerable areas to TB injury. For example, while performing a fascia-periosteal flap during a surgical procedure, the posterior end of the ZA must be cut and pulled with a fish hook, which may damage the TB of the facial nerve in the ZA region (Meybodi *et al*., 2017). Additionally, the fascia layers of the ZA region are closely fused, the soft tissue is buffered between the fascia, and reduced subcutaneous tissue atrophy may occur in elderly patients (Dahlke & Murray, 2011). The nerve course of the ZA region is relatively shallow compared with that of the temporal and buccal regions; its anatomical position is close to the incision (Jose *et al*., 2021). In ZA fracture treatment, the distribution of the temporal branches must be understood to identify the injured facial nerve (Wildan & Nasser, 2016; Ji *et al*., 2018). Previous anatomical studies have focused on the endings of the TB of the facial nerve near the temporal region and the entry point of the lateral orbital muscle; however, injury to the nerve trunk is more serious and may cause muscle paralysis in a large area (Pitanguy & Ramos, 1966). These consequences are more critical in patients with fewer TBs and a lack of nerve branches (Li *et al*., 2018). In this experiment, the fine anatomy of traditional gross specimens and the observation of plastinated sections of P45 were used to obtain detailed anatomical data on TB across the ZA region and provide guidance for clinical operations.

MENGKE, N. S.; LI, F. F.; ZHANG, Q.; SU, C.; CHUN, P.; MA, X. D.; QIN, T.; CHI, Y. Y.; YU, S. B. & SUI, H. J. Estudio clínico y anatómico sobre la localización del ramo temporal del nervio facial que cruza el arco cigomático. *Int. J. Morphol., 41(3)*:959-964, 2023.

RESUMEN: El objetivo de estudio fue esclarecer el trayecto del ramo temporal del nervio facial (RT) que cruza el arco cigomático (AC). Se disecaron la región cigomática de 18 especímenes de cabezas sin fijar de individuos adultas y se documentó la ubicación del RT y su número de ramos. La relación jerárquica entre el ramo temporal y el tejido blando en esta región se observó en 64 cortes plastinados o P45. 1º El RT cruza el AC como tipo I (21,8 %), tipo II (50,0 %) y tipo III (28,1 %). 2º A nivel del margen superior del AC, la distancia promedio entre el tronco anterior de RT y la parte anterior de la aurícula fue de 36,36±6,56 mm, para el tronco posterior fue de 25,59±5,29 mm. A nivel del margen inferior del AC, la distancia promedio entre el tronco anterior del RT y la parte anterior de la aurícula era de 25,77±6,19 mm, para el tronco posterior era de 19,16±4,71 mm. 3º La longitud media de RT fue de 62,06±5,36 mm. EL RT cruzaba el margen inferior del AC a una distancia media de 14,67±6,45 mm. El RT cruzaba el margen superior del AC a una distancia media de 9,08±4,54 mm. 4º Anivel del AC, el RT pasaba por la superficie del pericráneo mientras se encuentra por debajo del SMAS. El RT cruza oblicuamente el tercio medio del margen superior del AC y la unión del tercio medio y el tercio posterior del margen inferior del AC por debajo del SMAS, más allá del periostio. Se sugiere que esta área debe evitarse en la operación clínica para evitar la lesión de la RT.

PALABRAS CLAVE: Rama temporal del nervio facial; Arco cigomático; Técnica de plastinación seccional P45.

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Corresponding author:
Hong-jin Sui
Department of Anatomy
College of Basic Medicine
Dalian Medical University
Dalian 116044
Liaoning Province
CHINA

E-mail: suihj@hotmail.com