A study on branching pattern of branches of middle meningeal artery based on meningeal grooves present in the cranial cavity in south Indian dry skulls

Running title: Analysing the branching pattern of branches of middle meningeal artery based on meningeal grooves present in the cranial cavity

Abstract:

Aim:

To study the branching pattern of branches of the middle meningeal artery based on meningeal grooves present in the cranial cavity.

Introduction:

Middle meningeal artery is the major human dural artery. It is a neurologically very important artery for treatment and study of various neural health problems. Its origin and course can vary a lot in relation with embryological development. Complex sequences of MMA gives many opportunities for variant anatomy. It is clinically very important.

Materials and methods:

In this study we decided to investigate the anatomical organisation of the MMA, its branching pattern by taking south indian human dry skulls (N=30). It can be easily traced next to foramen spinosum.The statistical analysis was performed using the t-test calculator.

Result:

Most of the skulls had its middle branch of MMA from the anterior branch.There were many variations observed in the branching pattern.

Conclusion;

The branching pattern had many anatomical variations, which differed from one skull to another. The future scope of this study is to analyse skulls of people from different ethnical groups, observe the variations and trace the correlations.

Keywords:

Middle meningeal artery, variant anatomy, dry skull, neurological importance, foramen spinosum.

Introduction:

The knowledge of the anatomical arrangements of the middle meningeal artery (MMA) is of great importance in surgery and radiology.(1–4) This artery and its branches have implications in the pathophysiology of migraine by theories suggesting neurogenic information or cranial vasodilation(5,6). The detailed information of MMA like arising it from the maxillary artery, entry into the cranial cavity and its branches are very important in neurovascular surgeries (8) (9).It is very well known that MMA originates from maxillary artery as mentioned earlier, predominantly periosteal, irrigating bone and dura matter (10)(11,12)(13–15). It enters the floor of middle cranial fossa through foramen spinosum, travels latterly through a middle fossa bony ridge and curves anteriorly over upper greater a wing of sphenoid where it divides into frontal and parietal branch.(16,17). Frontal branch is located in a Bonny tunnel and is susceptible to tearing during trauma and this can produce many neurological disorders (18,19). The knowledge and awareness of these anatomic variations becomes important for surgeons to reduce risk of complication during surgical repair. The rupture of this artery at superolateral aspect of the skull i.e. at pterion leads to epidural haematoma (20) (21). Moreover the MMA plays some important role in treatment of many diseases and recurrent chronic subdural haematoma (CDSH) (22–25). By reviewing the medical importance of MMA, the study aimed to study various anatomical alterations in its branching pattern.

Materials and methods:

The present study analyzed 30 adult dry skulls from a private dental College in Chennai. Only skulls that had bony tunnels and grooves formed from the MMA on either side were used. The statistical analysis was performed using the t-test calculator. The study was approved by

Institutional Review Board, Saveetha Dental College and Hospitals, Saveetha Institute of Medical and Technical Sciences.

Tracing of the MMA:

The MMA was first traced by finding out the foramen spinosum. From the foramen spinosum the anterior and posterior division of the artery divides, close observation of the traces gives us the arisal branch of MMA either from anterior or posterior branch.

Fig 1

Fig 2

Fig 1 & 2: Shows the tracing procedure of the branching pattern of middle meningeal artery

Statistical analysis:

The statistical analysis was performed using the t-test calculator. The comparison between the morphometric organization of the right and left MMA from each skull were performed using a

paired t test. The P value of 0.05 or less was considered significant in all statistical tests performed at 95% confidence interval.

Results:

The present study observed that by analysing the 30 skulls the branching pattern of each side was analysed and a table with the cumulative data is plotted below (Table 1). From this table the study inferred that the majority of middle branch of MMA has arisen from the anterior branch than the posterior one. In which figure 3, 4, 5 represent the exceptions or the rare anatomical variations among the 30 skulls analysed. Figure 3 represents a dry skull with 2 posterior branches on each side and figure 4 represents a dry skull with a very larger artery size than the normal ones. Figure 5 represents a dry skull which has two different branching patterns on either side of it. Figure 6, 7 represents a dry skull where the anterior branch has formed a bonny tunnel. A p value of 0.5 was obtained which shows there is no significance between the differences observed in the right and left sides for the 30 dry skulls.

TABLE 1: Shows the number of the middle branches of MMA branching from anterior and posterior branches on each side.

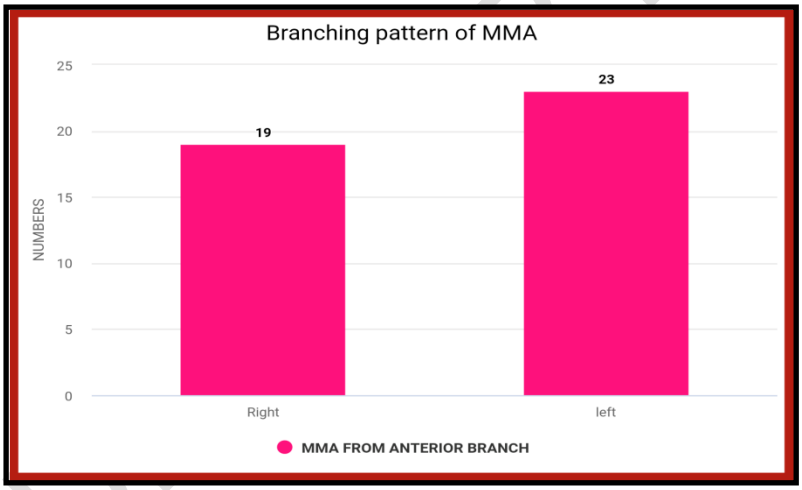
SIDE	ANTERIOR	POSTERIOR
RIGHT	19	11
LEFT	23	7

Fig3: Skull with 2 posterior branches

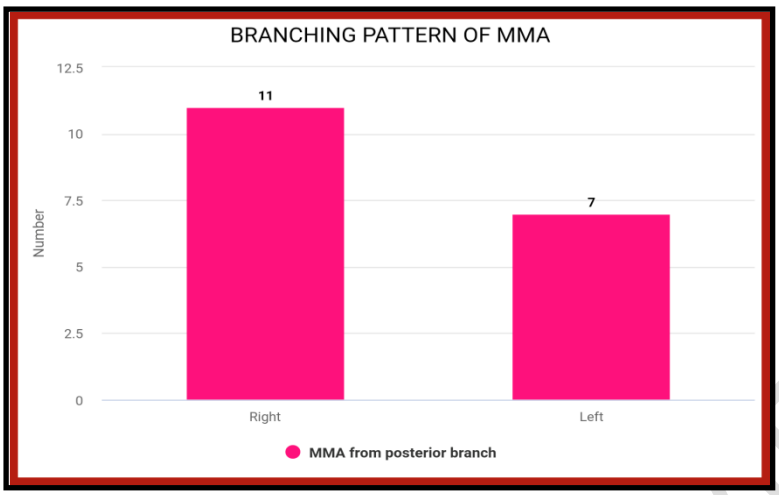
Fig4: Skull with large groove size

Fig 5: Skull with different branching pattern on both sides .

Fig 6:Skull where the anterior branch forms a bony canal.



Graph 1 shows the number of middle branches of MMA arising from the anterior branch on right and left sides. Y axis represents the number of skulls showing the mentioned pattern. X axis shows the respective sides whether left or right.



Graph 2 shows the number of middle branches of MMA arising from the posterior branch on right and left sides. Y axis represents the number of skulls showing the mentioned pattern.X axis shows the respective sides whether left or right.

Discussion:

In the present study we investigated the branching pattern of MMA either from anterior or posterior branch, a similar study where morphological and histological features of the bony canal through which the MMA passes was examined. The study observed that the middle meningeal grooves were deepened and gradually enveloped the MMA. Interestingly a study revealed histologically that the collagen tissues of the outer dural layer continued into the bony canal with the MMA (26). Similar to the present study, morphometric analysis of the occurrence of bony canal and measuring the length of it including frontal and parietal branches in the skull were noticed (27).

One more study of the functional and morphological pattern of MMA, its embryological differences were done to observe variations (28). The artery which surrounds the middle meningeal artery is the auriculo temporal artery; it arises from a complex embryological origin which is the reason for many anatomical variations (29). The importance of knowing about MMA is very important in surgical revascularization in case of vascular injuries. MMA can be injured easily if it passes through the bony canal, its morphological and histological features were studied to improve surgical results (26).

Chronic subdural hematoma (cSDH) is caused due to trauma which results in the injury of pterion which is right behind the temple, it is the thinnest part of the skull,where 4 types of bones come in contact.Underneath this lies the anterior region of MMA, thus it is often injured leading to cSDH (30). This disease is said to be more common among the elderly people. MMA embolization offers the potential for a minimally invasive less morbid treatment in this age group (31). The frontal branch of the MMA embedded in bony canal is currently omitted both in anatomical nomenclature,in this study we observed bony canal formation in few skulls out of the total similar to the study done by (32), where they studied the incidence and morphometry of the MMA bony canal and grooves on the skull base. In the present study we obtained the anatomical variations of the MMA, it's different branching patterns. However the limitation of this present study should be acknowledged, first the age, race, gender etc of the 30 dry skulls is unknown,therefore correlation of the branching pattern with age, gender etc cannot be done.The future scope of this study is to collect dry skulls from different parts of the world, from people belonging to different ethnical groups and also analyse the correlation of the branching pattern with age, gender, descendants, etc.

Conclusion:

The branching pattern of MMA in the skull shows variations in its branching and place where it branching, bony canal formation, etc. Further the study shows side differences in measuring the grooves. Thus the present study concluded that studying branching patterns of MMA in the cranial cavity is an important parameter in anatomical studies, anthropometric studies, etc. and prior knowledge of it is off utmost importance and serves as a guiding tool in neurovascular surgeries.

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