Investigation of Morphometric Characteristics of the Mesencephalon in a Healthy Turkish Population: an MRI Based Morphometric Study

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Abstract

Introduction: Due to the important functions of the mesencephalon, knowledge of its morphometric characteristics in a healthy population is important for any pathological diagnosis. The aim of this study was to determine the specific morphometric values of the mesencephalon in a healthy Turkish population.

Methods: MR images of 184 subjects (98 females, 86 males) with a mean age of 47.33 years (range 18 to 85 years) were included in the study. Then, parameter measurements were performed on 1.5 T MR images and MicroDicom Dicom Viewer 2022.1 software program was used for the measurements.

Results: The mean sagittal diameter of the right cerebral peduncle was 17.17±2.03 mm, the mean cross-sectional area of the right cerebral peduncle was 171.75±32.81 mm², the mean transverse diameter of the left cerebral peduncle was 16.60±2.32 mm, sagittal diameter of tectum and tegmentum 17.01±1.57 mm, cross-sectional area of tectum and tegmentum 223.40±27.37 mm² and pontomesencephalic angle 52.03°±10.61°, while in males these values were 18.26±2.38 mm, 182.61±38.57 mm², 17.39±2.57 mm, 17.76±1.90 mm, 237.20±35.94 mm² and 56.77°±9.78°, respectively. Except for the mamillopontine distance, there was a statistically significant difference between genders in the other parameters (p<0.05).

Conclusion: In conclusion, the findings related to the mesencephalon obtained in this study are presented for the first time in a healthy Turkish population. Especially cerebral peduncle cross-sectional area, tectum and tegmentum cross-sectional area, and cerebral peduncle transverse diameter can be evaluated clinically. We believe that knowledge of these values will guide specialists and radiologists in the diagnosis of any pathologic condition. Furthermore, the pontomesencephalic angle and mamillopontine distance have been identified as a potentially useful landmark in the diagnosis of intracranial hypotension and hydrocephalus. In particular, these angles can be measured in patient groups and may be a potential landmark in making an alternative diagnosis.

Categories: Anatomy, Radiology
Keywords: pontomesencephalic angle, turkish population, magnetic resonance imaging, mesencephalon morphometry, age and sex differences

Introduction

The brain stem consists of three parts called medulla oblongata, pons and mesencephalon. This structure connects the brain, cerebellum and spinal cord [1-3]. Moreover, it plays a very important role in regulating motor, sensory, sympathetic and parasympathetic effects, being the center of vital reflexes and being the exit points of cranial nerves [4]. The most rostral part of the brainstem, located between the pons and diencephalon, is the mesencephalon. The mesencephalon is divided into two parts: cerebral peduncle and tectum mesencephalicum. The nuclei of cranial nerves III (Oculomotor nerve) and IV (Trochlear nerve) and part of the nucleus of cranial nerve V (Trigeminal nerve) are located here. This part of the brain is the reflex center for both the eye and vision. It is also responsible for dopamine balance with the substantia nigra and voluntary movements with the red nucleus [1-3].

Normal brain development, maturation and the effects of aging are well documented in the literature. Since the advent of Magnetic Resonance Imaging (MRI), it has been possible to describe the structural anatomy and morphology of the brain with great accuracy [5]. A number of diseases, as well as the aging process, are known to be associated with a reduction in the size or atrophy of various structures of the brain. Diagnosis of such diseases often utilizes measurements from MRI images, which are routinely and easily performed [4-7]. Measurements of various structures of the brain, especially those known to be associated with atrophy of the brainstem, play a critical role in the diagnosis of neurodegenerative pathologies. Pontomesencephalic angle (PMA) and mamillopontine distance (MPD) have been found useful in the diagnosis of intracranial...
hypotension. It has also been reported that MPD is a useful aid in the diagnosis of hydrocephalus [8-12].

In the literature review, it was noteworthy that there were not enough morphometric studies on the brainstem. In particular, no specific morphometric study on the mesencephalon in the Turkish population was found in the literature. For the reasons mentioned above, we believe that knowing the morphometric properties of the mesencephalon in healthy individuals will make an important contribution to radiologists and specialist physicians in the diagnosis of any pathology.

The aim of this study was to reveal the morphometric properties of the mesencephalon in a healthy Turkish population by using brain MR images and classifying them according to age and gender.

**Materials And Methods**

This study was approved by the Non-Interventional Ethics Committee of Niğde Ömer Halisdemir University (Ethic Approval code: 2023/09-05) and was conducted in accordance with the principles of the Declaration of Helsinki. A total of 184 people (98 female, 86 male) with MR images between December 2020 and November 2022 were included in the study. The mean age of the participants was 47.33 years (range 18 to 85 years). Patients between the ages of 18-85 who presented to the hospital with headache and underwent brain MRI without any pathology were included in the study, while those who had previously undergone intracranial surgery, had any tumor, etc. lesions/pathologies in the brain and brainstem were excluded from the study. The participants were divided into 6 groups according to their ages: 18-35 (Group 1), 36-45 (Group 2), 46-55 (Group 3), 56-65 (Group 4), 66-75 (Group 5) and 76-85 (Group 6).

Parameters and Reference Points Measured in the Study and were shown in figure 1A-D and figure 2A-D.

**FIGURE 1: Mesencephalon morphometric measurements**

(A: Tectum and tegmentum sagittal diameter, B: Tectum and tegmentum transverse diameter, C: Pedunculus cerebri sagittal diameter, D: Pedunculus cerebri transverse diameter)
FIGURE 2: Mesencephalon morphometric measurements

(A: Tectum and tegmentum cross-sectional area, B: Pedunculus cerebri cross-sectional area, C: Mamillopontine distance, D: Pontomesencephalic angle)

Sagittal Diameter of Tegmentum and Tectum (SDTT) (mm): Distance between the anterior and posterior most point of the tegmentum and tectum at the level of the chiasma opticum on T2 sequence and transverse plane (Figure 2A).

Tegmentum and Tectum Transverse Diameter (TDTT) (mm): Distance from the most medial to the most lateral point of the tegmentum and tectum at the level of the chiasma opticum on T2 sequence and transverse plane (Figure 2B).

Pedunculus Cerebri Sagittal Diameter (SDPC) (mm): Distance from the most anterior to the most posterior point of the pedunculus cerebri at the level of the chiasma opticum on T2 sequence and transverse plane (Figure 2C).

Pedunculus Cerebri Transverse Diameter (TDPC) (mm): Distance from the most medial to the most lateral point of the pedunculus cerebri at the level of the chiasma opticum on T2 sequence and transverse plane (Figure 2D).

Cross Sectional Area of Tegmentum and Tectum (CSATT) (mm²): Total surface area of the tegmentum and tectum at the level of the chiasma opticum on T2 sequence and transverse plane (Figure 2A).

Cross Sectional Area of the Pedunculus Cerebri (CSAPC) (mm²): Surface area of the pedunculus cerebri at the level of the chiasma opticum on T2 sequence and transverse plane (Figure 2B).

Mamillopontine Distance (MPD) (mm): Defined as the distance between a transverse line drawn from the lowest point of the corpus mamillare and a transverse line drawn from the highest point of the pons on T2 sequence and sagittal plane [11] (Figure 2C).

Pontomesencephalic Angle (PMA) (°): It is defined as the angle between the line drawn along the anterior
edge of the mesencephalon and the anterior superior edge of the pons in T2 sequence and sagittal plane [11] (Figure 2D).

All parameter measurements were performed on 1.5 T MR images and MicroDicom Dicom Viewer 2022.1 software program was used for the measurements.

Statistical Analysis

SPSS 23.0 package program was used in the statistical analysis of the study. Kolmogorov-Smirnov test was used to determine whether the data obtained were normally distributed. Then, it was determined that the data were normally distributed. Therefore, independent sample t test was used for the comparison of the parameters between genders and one way ANOVA test was used for the comparison between age groups.

Results

The mean and standard deviation values of the measurements related to the mesencephalon in male and female and whether there was a significant difference between the two genders are presented in Table 1. Accordingly, it was found to be statistically significant (p<0.05) that males had higher mean values than females in all other brainstem measurements except MPD (Table 1). The mean value of MPD was also found to be greater in males than females, but not statistically significant (p= 0.709) (Table 1).

<table>
<thead>
<tr>
<th>Parameters</th>
<th>Female (N=98) (Mean±SD)</th>
<th>Male (N=86) (Mean±SD)</th>
<th>p</th>
</tr>
</thead>
<tbody>
<tr>
<td>SDRPC</td>
<td>17.17 ±2.03</td>
<td>18.26±2.38</td>
<td>0.001</td>
</tr>
<tr>
<td>TDRPC</td>
<td>16.62±2.23</td>
<td>17.33±2.50</td>
<td>0.043</td>
</tr>
<tr>
<td>CSARPC</td>
<td>171.75±32.81</td>
<td>182.61±38.57</td>
<td>0.041</td>
</tr>
<tr>
<td>SDLPC</td>
<td>16.45±1.78</td>
<td>18.13±2.24</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>TDLPC</td>
<td>16.60±2.32</td>
<td>17.39±2.57</td>
<td>0.029</td>
</tr>
<tr>
<td>CSALPC</td>
<td>164.53±32.12</td>
<td>183.02±36.02</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>SDTT</td>
<td>17.01±1.57</td>
<td>17.76±1.90</td>
<td>0.004</td>
</tr>
<tr>
<td>TDTT</td>
<td>21.52±1.84</td>
<td>22.93±2.47</td>
<td>&lt;0.001</td>
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<tr>
<td>CSATT</td>
<td>223.40±27.37</td>
<td>237.20±35.94</td>
<td>0.004</td>
</tr>
<tr>
<td>MPD</td>
<td>6.39±1.01</td>
<td>6.45±0.99</td>
<td>0.709</td>
</tr>
<tr>
<td>PMA</td>
<td>52.03±10.61</td>
<td>56.77±9.78</td>
<td>0.002</td>
</tr>
</tbody>
</table>

TABLE 1: Distribution of mesencephalon related parameters according to gender

SDRPC: Right side pedunculus cerebi sagittal diameter; TDRPC: Right side pedunculus cerebi transverse diameter; CSARPC: Right side pedunculus cerebi cross-sectional area; SDLPC: Left side pedunculus cerebi sagittal diameter; TDLPC: Left side pedunculus cerebi transverse diameter; CSALPC: Left side pedunculus cerebi cross-sectional area; SDTT: Tectum+Tegmentum sagittal diameter; TDTT: Tectum+Tegmentum transverse diameter; CSATT: Tectum+Tegmentum cross-sectional area; MPD: Mamillopontine distance; PMA: Pontomesencephalic angle

The comparison of Pontomesencephalic angle/Mamillopontine distance (PMA/MPD), Tectum+Tegmentum transverse diameter/Tectum+Tegmentum sagittal diameter (TDTT/SDTT), Right side pedunculus cerebi cross-sectional area/Left side pedunculus cerebi cross-sectional area (CSARPC/CSALPC) ratios between genders is shown in Table 2. The mean values of PMA/MPD and TDTT/SDTT were higher in males than females, and the mean value of CSARPC/CSALPC was higher in females than males.

However, there was no statistically significant difference in all rates (p>0.05) (Table 2).
Table 2 shows the distribution of the rates of mesencephalon-related measurements according to gender. The table presents the mean, standard deviation, and statistical significance values for measurements such as PMA/MPD, TDTT/SDTT, CSARPC/CSALPC. The data indicates a statistically significant difference between males and females for most of these parameters, with some exceptions noted.

Table 3 provides the distribution of measurements related to the mesencephalon according to age groups. It includes parameters such as SDRPC, TDRPC, CSARPC, SDLPC, TDLPC, CSALPC, SDTT, TDTT, CSATT, MPD, and PMA. The table shows the mean, standard deviation, and statistical significance values for these parameters across different age groups. The data reveals significant differences in some parameters between different age groups.

Table 4 presents the distribution of measurements related to the mesencephalon according to age groups. It includes parameters such as SDRPC, TDRPC, CSARPC, SDLPC, TDLPC, CSALPC, SDTT, TDTT, CSATT, MPD, and PMA. The table shows the mean, standard deviation, and statistical significance values for these parameters across different age groups. The data reveals significant differences in some parameters between different age groups.

Table 5 shows the distribution of the ratios of mesencephalon-related measurements according to age groups. The table includes parameters such as PMA/MPD and TDTT/SDTT. The data indicates a statistically significant difference between age groups in both sexes for these parameters, with a significant difference found between age groups of both sexes in the CSARPC/CSALPC ratio (p<0.05) (Table 3).
### TABLE 4: Examination of the distribution of the rates of mesencephalon-related measurements according to age groups

<table>
<thead>
<tr>
<th>Parameters</th>
<th>Group 1 (N=46) (Mean±SD)</th>
<th>Group 2 (N=46) (Mean±SD)</th>
<th>Group 3 (N=34) (Mean±SD)</th>
<th>Group 4 (N=28) (Mean±SD)</th>
<th>Group 5 (N=22) (Mean±SD)</th>
<th>Group 6 (N=22) (Mean±SD)</th>
<th>p</th>
</tr>
</thead>
<tbody>
<tr>
<td>PMA/MPD</td>
<td>8.66±1.41</td>
<td>8.82±1.74</td>
<td>8.83±2.69</td>
<td>7.36±2.38</td>
<td>8.66±1.72</td>
<td>10.78±2.12</td>
<td>0.001</td>
</tr>
<tr>
<td>TDTT/SDTT</td>
<td>1.24±0.15</td>
<td>1.27±0.14</td>
<td>1.25±0.12</td>
<td>1.35±0.17</td>
<td>1.35±0.14</td>
<td>1.31±0.08</td>
<td>0.009</td>
</tr>
<tr>
<td>CSARPC/CSALPC</td>
<td>1.07±0.19</td>
<td>1.00±0.19</td>
<td>0.98±0.08</td>
<td>1.08±0.21</td>
<td>1.02±0.21</td>
<td>1.03±0.08</td>
<td>0.160</td>
</tr>
</tbody>
</table>

Table 4 shows the mean, standard deviation and statistical significance values of measurements related to mesencephalon in all age groups in males. When Table 5 is evaluated, it is seen that there is a statistically significant difference between age groups in SDRPC, SDLPC, TDLPC, MPD parameters in male gender (p < 0.05).

### TABLE 5: Distribution of mesencephalon-related diameters and ratios of mesencephalon-related measurements according to age groups in males (N= 86)

<table>
<thead>
<tr>
<th>Parameters</th>
<th>Group 1 (N=20) (Mean±SD)</th>
<th>Group 2 (N=28) (Mean±SD)</th>
<th>Group 3 (N=10) (Mean±SD)</th>
<th>Group 4 (N=10) (Mean±SD)</th>
<th>Group 5 (N=16) (Mean±SD)</th>
<th>Group 6 (N=2) (Mean±SD)</th>
<th>P</th>
</tr>
</thead>
<tbody>
<tr>
<td>SDRPC</td>
<td>18.50±2.32</td>
<td>19.19±2.87</td>
<td>17.99±1.17</td>
<td>17.92±1.14</td>
<td>16.91±2.20</td>
<td>16.52±0.00</td>
<td>0.047</td>
</tr>
<tr>
<td>TDRPC</td>
<td>16.83±2.36</td>
<td>17.67±2.70</td>
<td>17.48±2.58</td>
<td>17.95±2.03</td>
<td>17.12±2.73</td>
<td>15.40±0.00</td>
<td>0.667</td>
</tr>
<tr>
<td>CSARPC</td>
<td>183.45±41.63</td>
<td>187.09±34.43</td>
<td>195.32±21.82</td>
<td>180.73±11.33</td>
<td>170.72±48.69</td>
<td>152.50±0.00</td>
<td>0.526</td>
</tr>
<tr>
<td>SDLPC</td>
<td>18.46±2.57</td>
<td>18.81±2.55</td>
<td>18.97±0.69</td>
<td>17.19±1.26</td>
<td>16.85±1.63</td>
<td>15.96±0.00</td>
<td>0.017</td>
</tr>
<tr>
<td>TDLPC</td>
<td>17.47±2.67</td>
<td>17.13±1.90</td>
<td>17.23±2.00</td>
<td>18.06±1.41</td>
<td>18.15±3.60</td>
<td>11.76±0.00</td>
<td>0.030</td>
</tr>
<tr>
<td>CSALPC</td>
<td>182.02±40.37</td>
<td>190.80±42.19</td>
<td>190.76±11.56</td>
<td>175.82±16.91</td>
<td>175.72±36.59</td>
<td>140.06±0.00</td>
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<tr>
<td>SDLTT</td>
<td>17.82±2.11</td>
<td>18.15±2.07</td>
<td>17.91±0.68</td>
<td>17.59±0.49</td>
<td>17.21±2.40</td>
<td>16.24±0.00</td>
<td>0.567</td>
</tr>
<tr>
<td>TDTT</td>
<td>22.33±2.91</td>
<td>23.16±2.15</td>
<td>23.54±0.43</td>
<td>23.71±1.99</td>
<td>22.80±3.24</td>
<td>19.88±0.00</td>
<td>0.298</td>
</tr>
<tr>
<td>CSATT</td>
<td>234.95±42.39</td>
<td>250.14±32.61</td>
<td>235.61±28.59</td>
<td>244.86±28.31</td>
<td>217.02±35.53</td>
<td>209.47±0.00</td>
<td>0.059</td>
</tr>
<tr>
<td>MPD</td>
<td>6.90±1.13</td>
<td>6.43±1.07</td>
<td>5.63±0.51</td>
<td>6.80±0.71</td>
<td>6.20±0.75</td>
<td>6.55±0.00</td>
<td>0.018</td>
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<tr>
<td>PMA</td>
<td>58.82±9.00</td>
<td>56.79±9.25</td>
<td>53.29±6.62</td>
<td>53.59±14.84</td>
<td>56.67±8.73</td>
<td>70.17±0.00</td>
<td>0.225</td>
</tr>
<tr>
<td>PMA/MPD</td>
<td>8.59±1.13</td>
<td>8.93±1.44</td>
<td>9.57±1.73</td>
<td>8.01±2.44</td>
<td>9.21±1.59</td>
<td>10.71±0.00</td>
<td>0.122</td>
</tr>
<tr>
<td>TDTT/SDTT</td>
<td>1.26±0.16</td>
<td>1.28±0.14</td>
<td>1.31±0.05</td>
<td>1.35±0.10</td>
<td>1.33±0.14</td>
<td>1.22±0.00</td>
<td>0.481</td>
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<tr>
<td>CSARPC/CSALPC</td>
<td>1.00±0.05</td>
<td>1.01±0.25</td>
<td>1.02±0.06</td>
<td>1.03±0.25</td>
<td>0.96±0.14</td>
<td>1.09±0.00</td>
<td>0.916</td>
</tr>
</tbody>
</table>

Table 5 describes the values of measurements related to the mesencephalon in female in all age groups. According to these findings, there is a statistically significant difference between age groups in SDRPC, TDRPC, SDLPC, TDLPC, TDTT, MPD, PMA, PMA/MPD, TDTT/SDTT, CSARPC/CSALPC parameters in female gender (p < 0.05) (Table 6).
Discussion

The brain stem, which consists of three parts: medulla oblongata, pons and mesencephalon, has a small area in the central nervous system. However, it is of vital importance as it has functions such as respiratory and circulatory centers, swallowing and vocalization, vision, hearing reflex, pupillary reflex, [13-15]. It is also an important part of the nervous system where the pathways connecting the spinal cord to the cortex and the cortex to the spinal cord pass and neurons change. The mesencephalon is the shortest and uppermost part of the brain stem. It extends between the aqueduct of midbrain tectum and tegmentum sections connecting the 3rd ventricle to the 4th ventricle in the CSF circulation. The nucleus ruber and substantia nigra, two important nuclei responsible for voluntary movements, the nuclei of the 3rd (n. oculomotorius), 4th (n. trochlearis) cranial nerves and a nucleus of the 5th (n. trigeminus) cranial nerve are located here [16-18].

In this study, the detailed morphometric values of the mesencephalon were examined in a healthy Turkish population, which is the first of its kind in the literature among certain age groups in men and female. Table 1 shows that the measurements of the mesencephalon, except for the mamillopontine distance (MPD), were statistically significantly higher in males than females (p <0.05).

Kariev et al. (2019) reported that MPD is an alternative measurement with high specificity in the diagnosis of obstructive hydrocephalus. In another study with 43 patients and 30 control groups, the mean MPD value of the patient group was found to be 3.4 mm and 9.8 mm in the control group [5,10]. In this study conducted in a healthy Turkish population, it was determined that the mean MPD value of male was 6.45 mm and that of female was 6.39 mm. However, there was no statistically significant difference between genders (p>0.05). In addition, according to the results of this study, it is shown in table 3 that there is a statistically significant difference in MPD value according to age groups (p <0.05). The highest value was 6.97 mm in the 56-65 age group (Group 4) and the lowest value was 6.12 mm in the 76-85 age group (Group 6). In the study conducted by Debnath et al. (2022) in a healthy Indian population, it was found that the mean MPD value of male was 8.60 mm and 7.92 mm in female and there was a statistically significant difference between the sexes.
Shah et al. (2013) reported that MPD values of 5.5 mm and less and PMA values of 50° and less were specific values suggestive of intracranial hypotension [11]. In this study conducted in a healthy Turkish population, it was found to be statistically significant (p < 0.05) that the mean PMA value was 56.77° in male and 52.03° in female (Table 3). There was also a statistically significant difference between age groups in terms of PMA value. When the PMA value was analyzed in age groups in males and females, the highest age group was group 6 with 70.17° and the lowest age group was group 3 with 55.29° and there was no statistically significant difference in terms of age groups (p > 0.05), while in females, the highest age group was group 6 with 64.38° and the lowest age group was group 4 with 48.17° and there was a statistically significant difference between age groups (p < 0.05) (Table 5, Table 6). In addition, PMA/MPD ratio was also analyzed in this study. This value was found to be 8.91 in males and 8.38 in females and no statistical difference was found between both sexes (Table 2). We believe that knowing this ratio in a healthy population will be an important guide in the detection of pathologic conditions.

Semnic et al. (2005) reported that the transverse diameter of the pedunculus cerebri was 93% reliable in the diagnosis of Wilson’s disease. They reported that the mean transverse diameter of the pedunculus cerebri was 11 mm in the patient group and 12.9 mm in the control group of healthy subjects [19]. In this study, the transverse diameter of the pedunculus cerebri was measured separately on the right and left sides. In females, the mean value of the transverse diameter of the pedunculus cerebri on the right side was 16.62 mm and the mean diameter of the pedunculus cerebri on the left side was 16.60 mm. In male, this value was 17.33 mm on the right side and 17.39 mm on the left side, and there was a statistically significant difference between male and female on both the right and left sides (p < 0.05). In addition, in this study, the transverse diameter of the pedunculus cerebri on the right side in males and females was examined separately between age groups and there was no statistically significant difference between the age groups, while there was a significant difference between the age groups on the left side (Table 3). In female, the statistical difference between the transverse diameter of the pedunculus cerebri on both the right and left sides was statistically significant between age groups (Table 4). In addition to these findings, the ratio of the transverse diameter of the right-sided pedunculus cerebri to the transverse diameter of the left-sided pedunculus cerebri was examined and it was found that this ratio was 1 in male and 1.05 in female. However, this ratio is not statistically significant (Table 2). We think that knowing this ratio in healthy subjects can be evaluated in the detection of pathologic conditions. In the literature, it has been reported that various structures of the brain undergo atrophy in some diseases as well as the aging process [4-7]. In this study, the cross-sectional areas of the mesencephalon at the level of chiasma opticum, which are not available in the literature, were revealed between age groups in male and female sex. The cross-sectional area of the pedunculus cerebri on the right side was highest in group 3 with 195.32 mm² in males and lowest in group 6 with 152.50 mm² in females. On the left side, the highest age group was group 2 with 190.80 mm² and the lowest age group was group 6 with 140.06 mm². In the tectum and tegmentum cross-sectional area, the age group with the highest value was group 2 with 250.14 mm² and the age group with the lowest value was group 5 with 209.47 mm². The age group with the highest cross-sectional area of the pedunculus cerebri on the right side was group 1 with 186.96 mm² and the lowest was group 6 with 155.50 mm². On the left side, the highest age group was group 3 with 171.83 mm² and the lowest age group was group 4 with 146.15 mm². In the tectum and tegmentum cross-sectional area, the highest value of 230.42 mm² belonged to group 6 (76-83 years), while the lowest value of 214.34 mm² belonged to group 1 (18-35 years). We believe that knowing these values in both sexes and age groups will be an important guide in revealing the presence of any pathology, whether symptomatic or not.

Conclusions
In conclusion, this is the first study in which pontomesencephalic angle/mamillopontine distance, tectum and tegmentum transverse diameter/tectum and tegmentum sagittal diameter, right pedunculus cerebri cross-sectional area/left pedunculus cerebri cross-sectional area ratios, pedunculus cerebri cross-sectional area and tectum and tegmentum cross-sectional area values were revealed in healthy Turkish population. We are of the opinion that revealing the specific morphometric values of the mesencephalon in the healthy Turkish population in detail, both in male and female gender and between different age groups, will be a guide for specialists and radiologists in the differential diagnosis of any pathologic condition and surgical applications.

Additional Information
Disclosures
Human subjects: Consent was obtained or waived by all participants in this study. Non-Interventional Ethics Committee of Niğde Omer Halisdemir University issued approval 2023/09-05. This study was approved by the Non-Interventional Ethics Committee of Niğde Omer Halisdemir University (Ethic Approval code: 2023/09-05) and was conducted in accordance with the principles of the Declaration of Helsinki.
Animal subjects: All authors have confirmed that this study did not involve animal subjects or tissue.
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**References**