Introduction

After emerging from the transverse process of the axis (C2), the vertebral artery (VA) flexes posteriorly and laterally towards the atlas (C1) costotransverse foramen, forming the suboccipital segment, which contours the posterior arch of C1. After a short, inclined tract posterior to the lateral mass of the C1, the suboccipital segment of the VA forms an impression onto the upper surface of the arch of C1, known as the vertebral artery sulcus (VAS). Occasionally, a small bony arch is found to connect the retroglenoid tubercle with the posterior arch of C1. This anatomical structure is known as ponticulus posticus (PP). The partial or total incidence of PP reported in the literature ranges from 5.14% to 51%. The clinical implication of PP includes the cervicogenic migraine, vertigo, and the Barre-Lieou syndrome. The scope of this paper is to determine the incidence of PP in isolated cadaveric vertebrae in the Brazilian population. The cervical vertebrae C1 from thirty not identified adult cadavers were examined at the Laboratory of Anatomy of the Federal University of Sergipe, Brazil. PP was present in 40% of evaluated C1 and it involved a complete bony arch in 42% of the cases. In 58% of the cases, PP was observed bilaterally. In the cases where the presence of PP was unilateral, this structure was situated exclusively on the right, even though a bigger incidence on the left side has been described for the majority of right-handed people. PP was a frequent finding in our study and its presence always must be suspected while setting the diagnosis of cervicogenic chronic headache and cervical pain without radiation to upper limbs.

Key words: Spine, atlas, ponticulus posticus, incidence.
Material and methods

Observations were performed at the Laboratory of Anatomy (Federal University of Sergipe, Brazil). Thirty adult C1 vertebrae from unidentified cadavers were examined. Vertebrae were collected from locally originated subjects, who had been buried as indigents. There was no distinction regarding sex, age, or race. The posterior vertebral arches were studied regarding the presence of PP, and findings were photographed.

Results

PP was observed in 12 of the 30 C1s. PP were classified into 5 types (Table 1).

Type I (n=3), where PP was completely present on both sides forming an arch that delimited a second foramen with the VAS; Type II (n=2), where PP was completely present in only one side; Type III (n=4), where an incomplete PP was present, forming a semi-arch or bone spicule delimiting a second foramen with an open VAS; Type IV (n=3), where PP was incompletely present in only one side; and Type V (n=0), where PP would be complete in one side, and not complete on the contralateral side (Figure 1).

Of the five cases where the structure was classified as unilateral (two of Type II, and three of Type IV), the anatomical finding was seen on the right side. Table 1 describes the incidence of different types found in the present study. It can be seen that no case with a complete PP on one side and incomplete on the contralateral side was observed.

Discussion

LeMinor and Trost classified 893 C1 bones from humans and primates regarding the presence and type of PP found. The occurrence of PP ranged from the complete absence to the constant presence, depending on the primate species; there was a trend of that structure disappearing in hominids. Authors concluded that the presence of a dorsal PP in humans is a leftover from the evolving trend of its disappearance in hominids. In quadrupeds, the presence of PP is constant. In those animals, neck extensor muscles and the posterior atlanto-occipital membrane attach onto that region. In humans, the vertical weightbearing from the head occurs at the atlantocondylar joint. According to Lamberty and Zivanovic’, PP is considered a primitive structure that has been involuted due to a lesser need of ligament stability in humans.

Breathnach considered that PP resulted from ossification of the atlanto-occipital membrane and the oblique ligament. The idea that PP represented a degenerative process was rejected when Lamberty and Zivanovic’ described the presence of those structures in fetuses’ and children’s dissections.

Paraskevas et al investigated the presence of the vertebral artery canal (PP) in 176 C1 vertebrae, and observed the presence of a complete PP in 10.2% of cases, and incomplete in 24.4% of cases. PP was more often found in men and adults 45 years of age or older. The measured superoinferior diameter ranged from 4.6 mm to 6.1 mm, and the anteroposterior diameter ranged from 5.6 mm to 7.2 mm. A deep, contralateral SAV was observed in 93.5% of the unilateral PP. This may be considered as indirect evidence of VA compression, thus implying a compensatory flow by the contralateral VA.

Studies of the VAS morphology have shown in 40% of the cases the presence of a bone bridge with the posterior

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Table 1: Incidence of ponticulus posticus (n=30).

<table>
<thead>
<tr>
<th>Presence of the ponticulus/Type</th>
<th>Right</th>
<th>Left</th>
<th>Bilateral</th>
</tr>
</thead>
<tbody>
<tr>
<td>Complete</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Type I</td>
<td>0</td>
<td>0</td>
<td>3</td>
</tr>
<tr>
<td>Type II</td>
<td>2</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Incomplete</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Type III</td>
<td>0</td>
<td>0</td>
<td>4</td>
</tr>
<tr>
<td>Type IV</td>
<td>3</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Type V</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
</tbody>
</table>

Figure 1: Human C1 vertebrae dissected presenting Ponticus Posticus. (1.1): where PP was completely present in only one side, (1.2): where an incomplete PP was present, forming a semi-arch or bone spicule delimiting a second foramen with an open VAS, (1.3): where PP was completely present on both sides forming an arch that delimited a second foramen with the VAS. (P): Ponticus, (L): Posterior arch, (S): Sulcus of the vertebral artery, (T): Lateral mass, (T): Transverse apophysis.
edge of the upper articular facet from the C1, forming a foramen. In our study, PP was observed either complete or incomplete; the complete arch was present in 42% (n=5) of cases. Hasan et al, after a literature review, reported an incidence ranging from 5.84% to 51%. Buna et al performed a review on different grades of PP, and concluded that incomplete PPs were present in about 35% of the dissected C1 vertebrae, while a complete PP was present in about 15%. In 58% (n=7) of the cases in our study, the PP was observed bilaterally. In cases where PP was unilaterally present, it was located exclusively on the right. Nevertheless, PP was more frequently found on the left side in the dissections from Hasan et al, and from Dhall et al. Dhall suggested that the highest incidence is on the left side for the majority of the right-handed population, as the right sternocleidomastoid muscle is stronger and would tend to tilt the head towards the opposite side. Nonetheless, in all five unilateral cases of types II and IV found in our series, PP was observed on the right side. Lamberty and Zivanovic believed that PP could cause cervicogenic headache, vertigo, and photophobia. The mechanism would be a VA compression by PP, thus causing vertebrobasilar circulatory ischemia. LeMinor associated the presence of a retrotransverse foramen to the acquisition of a standing posture, and resulting regional circulation change. Ercegovac and Davidovic, Sun, and Li et al reported several cases of headache, vertigo, and nausea relief with surgical decompression of that structure. PPs are commonly seen in lateral cervical spine radiographs and would suggest that the presence of that structure could be mistaken by a wide posterior arch during lateral mass or translaminar screw instrumentation on the C1. The presence of PP can be considered as a relative contraindication for high cervical spine manipulation.

Conclusion

Our study suggests that PP is a common anomaly that can be easily mistaken for an enlarged C1 posterior arch. We recommend that, before inserting a screw into something that appears to be an enlarged posterior arch, the surgeon should first review cervical spine scans to check whether a PP is present. The PP was a frequent finding in our study, and its presence must always be suspected in the differential diagnosis of vertebrobasilar insufficiency, cervicogenic headache, and cervical pain with no radiation to the upper limbs.

References


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