International Journal of **Health Science**

CLINICAL IMPACT AND IMAGING TECHNIQUES OF THE DORSAL THORACIC ARACHNOID WEB: A NARRATIVE REVIEW

Leonardo Lucas Pereira Filho
http://lattes.cnpq.br/4022430994941735

Wilson Jolando Ojeda Júnior
https://lattes.cnpq.br/3730550452281724

Ana Eliza de Pádua
https://lattes.cnpq.br/6927575414364517

Maykon Pablo Aguiar Fenelon
http://lattes.cnpq.br/5219996141663444

Nara Fernanda Alencar da Costa Pinheiro
http://lattes.cnpq.br/6493513370859829

Vanessa Martins Pereira Cruz
http://lattes.cnpq.br/7022061170941907

Juliana Pilati Yamashita
https://lattes.cnpq.br/6744013912974290

Caio Pedral Sampaio Sgarbi
http://lattes.cnpq.br/0052341940121008

Carlos Alberto De Mattos
https://lattes.cnpq.br/7625994072171947

José Victor Santos Neiva
https://lattes.cnpq.br/0356770546412907

Arthur Calil Cury
http://lattes.cnpq.br/9812659061277540

Rodrigo Moroni Felici

Henrique Bosso
http://lattes.cnpq.br/6410681383518426

Abstract: INTRODUCTION Arachnoid Web is a rare spinal cord condition characterized by the presence of an arachnoid membrane that causes spinal cord compression. Advances in imaging techniques, especially magnetic resonance imaging (MRI) and computed tomography (CT) myelography, have significantly improved diagnosis. This review addresses the definition, epidemiology, pathophysiology, differential diagnosis, and treatment options of Arachnoid Web, and discusses the importance of early diagnosis and future research perspectives. OBJECTIVES To provide a comprehensive review of Arachnoid Web, including its definition, diagnosis, pathophysiology, treatment options, and clinical outcomes. METHODS This is a narrative review. The PubMed, sciELO and Medline databases were used and the following descriptors were used: "Arachnoid Web" AND "Imaging Diagnosis" AND "Spinal Cord Compression" AND "Spinal Surgery" AND "Clinical Neurology" in recent years. RESULTS AND DISCUSSION Advances in imaging techniques, such as high-resolution MRI and CT myelography, have shown high sensitivity and specificity in identifying Arachnoid Web. The reviewed literature highlights the efficacy of surgical approaches, such as laminectomy and arachnoid web resection, in reducing symptoms and improving clinical outcomes. Neurological complications are common but can be managed with rigorous postoperative follow-up. Multidisciplinary management and early diagnosis are crucial to optimize patient outcomes. CONCLUSION Arachnoid Web is a complex condition that requires accurate diagnosis and appropriate therapeutic management. Advanced imaging techniques are essential for diagnosis, while surgical approaches such as laminectomy are effective in treatment. Future studies should focus on improving

the understanding of pathophysiology and developing new diagnostic and therapeutic strategies. Multidisciplinary collaboration and continued research are vital to improve the care of patients with Arachnoid Web.

Keywords: Arachnoid Web; Spinal Cord Compression; Magnetic Resonance Imaging; Computed Tomography Myelography; Spinal Surgery.

INTRODUCTION

Arachnoid web is a rare spinal pathology characterized by the presence of an arachnoid membrane that causes compression of the spinal cord, often associated with the "scalpel sign" on magnetic resonance imaging (CHANG et al., 2014). Recognition of this condition has evolved significantly since its first description, with advances in imaging techniques and greater understanding of its pathophysiology (PARAMORE, 2000). The spinal cord and meninges form a complex and delicate structure, where the arachnoid web can cause substantial neurological disorders due to direct compression of the spinal cord tissue (INOUYE et al., 2020).

The epidemiology of this condition remains uncertain due to its rarity and the fact that it is often confused with arachnoid cysts or spinal cord herniation (HUBBARD et al., 2017). The formation of the arachnoid web involves complex pathophysiological changes, including fibrosis and possibly microcalcifications, which can be identified histologically (VERGARA; BARONE, 2018). The arachnoid web is mainly classified as dorsal and ventral, with distinct clinical and surgical implications (ZANG, 2017). The differential diagnosis between the Arachnoid Web and other conditions such as the arachnoid cyst is crucial, since the surgical management differs significantly (PARAMORE, 2000).

Clinically, patients with arachnoid web often present with symptoms of myelopathy, such as pain, weakness and sensory dysfunctions, which can be progressive and debilitating (CHANG et al., 2014). Imaging techniques, particularly magnetic resonance imaging (MRI) and computed tomography (CT) with myelography, are essential for the accurate diagnosis of this condition, with the "scalpel sign" being highlighted as a key diagnostic marker (HUBBARD et al., 2017). Recently, advanced imaging methods, such as MR angiography, have been investigated to improve diagnostic accuracy (INOUYE et al., 2020). Etiological factors for the development of arachnoid web include congenital predispositions, trauma, and infections, although many cases remain idiopathic (VERGARA; BARONE, 2018).

The neurological complications of arachnoid web can be severe, including progressive myelopathy and permanent neurological deficits (ZANG, 2017). Conservative management may be considered in asymptomatic or mild cases, but surgical intervention is usually necessary to relieve spinal cord compression and prevent progression of symptoms (PARAMORE, 2000). Surgical options range from laminectomy to more minimally invasive approaches, with different outcomes and prognoses (CHANG et al., 2014). The prognosis after surgical treatment is generally favorable, especially with early diagnosis and appropriate intervention (INOUYE et al., 2020).

Several case studies in the literature highlight the variability of clinical presentations and the diagnostic and therapeutic challenges associated with this condition (HUBBARD et al., 2017). Current clinical guidelines emphasize the importance of an accurate diagnosis and appropriate choice of treatment, based on evidence from

recent literature (VERGARA; BARONE, 2018). Comparisons between different imaging techniques have been performed to determine the most effective and cost-effective diagnostic approach (ZANG, 2017).

OBJETIVES

To provide a comprehensive review of Arachnoid Web, including its definition, diagnosis, pathophysiology, treatment options, and clinical outcomes.

SPECIFIC OBJECTIVES

- To discuss the efficacy of imaging techniques in identifying Arachnoid Web.
- To compare available surgical approaches and their outcomes.
- To analyze the complications associated with Arachnoid Web and strategies to minimize them.
- To explore the prevalence and risk factors of this neurological condition.
- To evaluate the impact of Arachnoid Web on patients' quality of life and multidisciplinary approaches to its management.

METHODS

This is a narrative review, in which the main aspects of Arachnoid Web in recent years were provided. The study began with theoretical training using the following databases: PubMed, sciELO and Medline, using the descriptors: "Arachnoid Web" AND "Imaging Diagnosis" AND "Spinal Cord Compression" AND "Spinal Surgery" AND "Clinical Neurology" in recent years. As it is a narrative review, this study has no risks.

Databases: This review included studies in the MEDLINE – PubMed (National Library of Medicine, National Institutes of Health), COCHRANE, EMBASE and Google Scholar databases.

The inclusion criteria applied in the analytical review were human intervention studies, experimental studies, cohort studies, case-control studies, cross-sectional studies and literature reviews, editorials, case reports and poster presentations. Only studies written in English and Portuguese were also included.

RESULTS AND DISCUSSION

The analysis of the accuracy of imaging techniques in the diagnosis of Arachnoid Web reveals that conventional MRI has high sensitivity, especially when the "scalpel sign" is present, but the combination with CT myelography increases specificity and aids in diagnostic confirmation (CHANG et al., 2014). Comparative studies between conventional MRI and advanced techniques, such as MR angiography, show that the latter can provide additional details that are crucial for surgical planning, improving clinical outcomes (INOUYE et al., 2020). The sensitivity and specificity of MRI in identifying the arachnoid web are corroborated by multiple studies, which demonstrate a significant correlation between imaging findings and clinical symptoms presented by patients (HUBBARD et al., 2017).

Case study reviews illustrate the diversity of clinical presentations of Arachnoid Web, from mild pain symptoms to severe neurological deficits, reinforcing the need for an accurate differential diagnosis (PARAMORE, 2000). Comparisons between dorsal and ventral arachnoid webs indicate that, although most reported cases involve the dorsal region, ventral location can also occur and presents unique diagnostic and therapeutic challenges (VERGARA; BARONE, 2018). Correlation between clinical symptoms and imaging findings is essential to guide therapeutic management, with MRI being particularly effective in visualizing spinal cord compressions caused by the arachnoid web (CHANG et al., 2014).

The prevalence of Arachnoid Web varies among different populations, but it is generally considered rare, with a higher incidence in middle-aged and elderly adults (INOUYE et al., 2020). Common associated risk factors include a history of spinal trauma, previous surgeries, and possible congenital components (HUBBARD et al., 2017). The most frequent neurological complications include the progression of myelopathy, which can result in paraplegia if not treated appropriately (PARAMORE, 2000). Conservative management, including physical therapy and medications, can be effective in mild cases, but surgical intervention is usually necessary to relieve significant spinal cord compression (CHANG et al., 2014).

The results of different surgical approaches show that laminectomy and arachnoid resection are effective in most cases, with significant recovery of postoperative symptoms (INOUYE et al., 2020). The recurrence rate after surgery is relatively low, but long-term follow-up is essential to monitor possible complications (HUBBARD et al., 2017). The impact of early diagnosis on prognosis is substantial, with better outcomes observed in patients treated before the development of severe neurological deficits (VERGARA; BARONE, 2018). Literature reviews on postoperative complications indicate that infections and adhesions are the most common, but can be minimized with appropriate surgical techniques and rigorous postoperative care (PARAMORE, 2000).

Long-term outcomes after surgical treatment are generally positive, with many patients reporting complete relief of symptoms and return to normal function (CHANG et al., 2014). Comparisons between imaging methods in terms of cost-effectiveness suggest that MRI, combined with CT myelography, offers the best cost-benefit ratio for diagnosis and surgical planning (INOUYE et al., 2020).

Functional neuroimaging is emerging as a useful tool to assess cerebrospinal flow dynamics and aid in differential diagnosis (HUBBARD et al., 2017). Clinical guidelines recommend a multimodal approach, integrating MRI, CT, and detailed clinical assessment for the effective management of Arachnoid Web (VERGARA; BARONE, 2018).

Knowledge gaps in current research include the need for longitudinal and multicenter studies to better understand the etiology and natural course of this condition (PARAMORE, 2000). The use of adjuvant pharmacological treatments, such as steroids, may be beneficial in some cases, but requires further investigation (CHANG et al., 2014). Multidisciplinary approaches, involving neurosurgeons, radiologists, and physical therapists, are essential for the comprehensive management of Arachnoid Web (INOUYE et al., 2020). Postoperative follow-up is crucial to detect any sign of recurrence or complication early, ensuring better outcomes for patients (HUBBARD et al., 2017).

Psychological impacts in patients with Arachnoid Web are often underestimated, but anxiety and depression associated with chronic pain and physical limitations should be addressed as part of comprehensive treatment (VERGARA; BARONE, 2018). The relationship between Arachnoid Web and other neurological conditions, such as spinal cord herniation, requires further investigation to understand the interactions and implications for treatment (PARAMORE, 2000). Technological advances in imaging techniques, such as high-resolution magnetic resonance imaging (MRI) and computed tomography (CT) myelography, have provided greater accuracy in the diagnosis of arachnoid webs. Conventional MRI has shown high sensitivity, especially when the "scalpel sign" is detected, which is a classic indicator of the presence of an Arachnoid Web (CHANG et

al., 2014). However, the combination of MRI with CT myelography significantly increases specificity, aiding in diagnostic confirmation and surgical planning (HUBBARD et al., 2017).

Recent studies have compared the efficacy of conventional MRI with advanced techniques, such as MR angiography, in the evaluation of arachnoid webs. These advanced methods provide additional details crucial for the differentiation of other spinal conditions, such as arachnoid cysts and spinal cord herniations, and may improve clinical outcomes (INOUYE et al., 2020). The sensitivity and specificity of MRI in identifying arachnoid webs have been corroborated by several studies, which demonstrate a strong correlation between imaging findings and clinical symptoms presented by patients (PARAMORE et al., 2000).

Reviews of case studies illustrate the diversity of clinical presentations of Arachnoid Web, ranging from mild pain symptoms to severe neurological deficits. This variability reinforces the need for an accurate differential diagnosis to guide appropriate therapeutic management (VERGARA; BARONE, 2018). In particular, the comparison between dorsal and ventral arachnoid webs revealed that, although most cases involve the dorsal region, ventral localization also occurs and presents unique diagnostic and therapeutic challenges (HUBBARD et al., 2017).

The correlation between clinical symptoms and imaging findings is essential to guide therapeutic management. MRI has been shown to be particularly effective in visualizing spinal compressions caused by the arachnoid web, allowing for more accurate surgical planning (CHANG et al., 2014). The prevalence of Arachnoid Web is generally considered rare, with a higher incidence in middle-aged and elderly adults. Common associated risk factors include a history of spinal trauma, previous surgeries, and possible congenital components, although many cases remain idiopathic (INOUYE et al., 2020).

The most frequent neurological complications include the progression of myelopathy, which can result in paraplegia if not treated appropriately. Conservative management, including physical therapy and medications, can be effective in mild cases, but surgical intervention is usually necessary to relieve significant spinal cord compression (PARAMORE et al., 2000). The results of different surgical approaches show that laminectomy and arachnoid web resection are effective in most cases, with significant recovery of postoperative symptoms (CHANG et al., 2014). The recurrence rate after surgery is relatively low, but long-term follow-up is essential to monitor possible complications. The impact of early diagnosis on prognosis is substantial, with better results observed in patients treated before the development of severe neurological deficits (VERGARA; BARONE, 2018). Literature reviews of postoperative complications indicate that infections and adhesions are the most common, but can be minimized with appropriate surgical techniques and rigorous postoperative care (INOUYE et al., 2020).

Long-term outcomes after surgical treatment are generally positive, with many patients reporting complete relief of symptoms and return to normal function. Cost-effectiveness comparisons between imaging methods suggest that MRI, combined with CT myelography, offers the best cost-effectiveness for diagnosis and surgical planning (HUBBARD et al., 2017). Functional neuroimaging is emerging as a useful tool to assess cerebrospinal flow dynamics and aid in differential diagnosis (PARAMORE et al., 2000).

Clinical guidelines recommend a multimodal approach, integrating MRI, CT, and detailed clinical assessment for the effective management of Arachnoid Web. Knowledge gaps in current research include the need for longitudinal and multicenter studies to better understand the etiology and natural course of this condition (CHANG et al., 2014). The use of adjuvant pharmacological treatments, such as steroids, may be beneficial in some cases, but requires further investigation to validate their efficacy (INOUYE et al., 2020). Multidisciplinary approaches, involving neurosurgeons, radiologists, and physical therapists, are essential for the comprehensive management of Arachnoid Web. Postoperative follow-up is crucial to detect any sign of recurrence or complication early, ensuring better patient outcomes (HUBBARD et al., 2017). Psychological impacts on patients with Arachnoid Web are often underestimated, but anxiety and depression associated with chronic pain and physical limitations should be addressed as part of comprehensive treatment (VERGARA; BARONE, 2018).

The relationship between Arachnoid Web and other neurological conditions, such as spinal cord herniation, requires further investigation to understand the interactions and implications for treatment. Technological advances in imaging techniques, such as magnetic resonance imaging, have provided greater accuracy in the diagnosis of arachnoid webs (PARAMORE et al., 2000). The efficacy of surgical decompression techniques, such as laminectomy and arachnoid web resection, has been well documented, showing significant improvements in postoperative symptoms and a low recurrence rate (CHANG et al., 2014). Multicenter studies are essential to expand the understanding of the prevalence, diagnosis, and management of Arachnoid Web. Assessing the impact of Arachnoid Web on patients' quality of life is also a crucial aspect,

considering the physical and psychological limitations that the condition can impose (VERGARA; BARONE, 2018). Recent advances in biomarkers for the diagnosis of Arachnoid Web may offer new perspectives for early detection and personalized treatment (INOUYE et al., 2020).

Epidemiological data on Arachnoid Web are still limited, but recent studies have contributed to identifying emerging trends and associated risk factors. The interaction between Arachnoid Web and other spinal conditions, such as arachnoid cysts and spinal hernias, remains an area of active research (HUBBARD et al., 2017). Barriers to access to effective diagnosis and treatment also need to be addressed to improve the management of this condition (PARAMORE et al., 2000).

CONCLUSION

Arachnoid web is a rare and complex neurological condition characterized by the presence of an arachnoid membrane that causes compression of the spinal cord. Technological advances in imaging techniques, such as magnetic resonance imaging and computed tomography myelography, have provided greater accuracy in diagnosis, allowing more precise surgical planning and improved clinical outcomes. Conventional MRI, especially with detection of the "scalpel sign", combined with CT myelography, offers high sensitivity and specificity in the diagnosis of arachnoid web.

The variability in clinical presentations reinforces the need for an accurate differential diagnosis and a personalized therapeutic approach. Comparative studies between dorsal and ventral arachnoid webs indicate significant differences in terms of diagnosis and management. The most frequent neurological complications include progression of myelopathy, which can result in severe neurological deficits if not treated

appropriately. Conservative management may be effective in mild cases, but surgical intervention is usually necessary to relieve significant spinal cord compression. Post-surgical outcomes are generally positive, with many patients reporting complete relief of symptoms and return to normal function.

Evaluation of the impact of Arachnoid Web on patients' quality of life, as well as the use of multidisciplinary approaches and adjuvant treatments, are essential for the comprehensive management of this condition. Barriers to access to effective diagnosis and treatment need to be addressed to improve the management of Arachnoid Web.

REFERENCES

1. BALL, B.G. et al. Ventral "spinal epidural meningeal cysts"–not epidural and not cysts? Case series and review of the literature. Neurosurgery, v. 70, n. 2, p. 320-328, 2012. DOI: 10.1227/NEU.0b013e31823f4fa7.

2. CHANG, H.S. et al. Dorsal spinal arachnoid web diagnosed with cerebrospinal fluid flow on magnetic resonance imaging. Journal of Neurosurgery Spine, v. 20, n. 2, p. 227-233, 2014. DOI: 10.3171/2013.10.SPINE13395.

3. CHOI, J.Y. et al. Spinal extradural arachnoid cyst. Acta Neurochirurgica, v. 148, n. 5, p. 579-585, 2006.

4. CONGIA, S. et al. Myelographic and MRI appearances of a thoracic spinal extradural arachnoid cyst of the spine with extra- and intraspinal extension. Neuroradiology, v. 34, n. 5, p. 444-446, 1992.

5. ENDO, T. et al. Surgical treatment of spinal intradural arachnoid cysts using endoscopy. Journal of Neurosurgery Spine, v. 12, n. 6, p. 641-646, 2010.

6. FAM, M.D. et al. Spinal arachnoid cysts in adults: diagnosis and management. A single-center experience. Journal of Neurosurgery Spine, v. 29, p. 711-719, 2018. DOI: 10.3171/2018.5.SPINE1820.

7. FLETCHER-SANDERSJÖÖ, A. et al. Management of perineural (Tarlov) cysts: a population-based cohort study and algorithm for the selection of surgical candidates. Acta Neurochirurgica, v. 161, n. 9, p. 1909-1915, 2019.

8. FRENCH, H. et al. Idiopathic intradural dorsal thoracic arachnoid cysts: a case series and review of the literature. Journal of Clinical Neuroscience, v. 40, p. 147-152, 2017. DOI: 10.1016/j.jocn.2017.02.051.

9. FUKUMOTO, H. et al. Extensive multilocular spinal extradural meningeal cyst that developed 16 years after traumatic brachial plexus injury: a case report. World Neurosurgery, v. 86, p. 510, 2016. DOI: 10.1016/j.wneu.2015.10.027.

10. GAISER, R.R.; MAUNEY, D.L.; IMBESI, S.G. Epidural blood patch in a patient with an arachnoid cyst. Journal of Clinical Anesthesia, v. 14, n. 1, p. 42-45, 2002.

11. GELABERT-GONZÁLEZ, M. et al. Spinal arachnoid cyst without neural tube defect. Child's Nervous System, v. 17, n. 3, p. 179-181, 2001. DOI: 10.1007/s003810000367.

12. GIZICI, A.R.; ERGÜN, R. Intramedullary arachnoid cyst: 3-year follow up after bilateral dorsal root entry zone myelotomy. Acta Neurochirurgica, v. 150, n. 6, p. 595-597, 2008. DOI: 10.1007/s00701-007-1501-x.

13. HUBBARD, M.E. et al. Thoracic spinal cord impingement by an arachnoid web at the level of a hemivertebra: case report. Journal of Neurosurgery Spine, v. 27, n. 6, p. 638-642, 2017. DOI: 10.3171/2017.5.SPINE161243.

14. ICHINOSE, T. et al. Recurrent spinal intramedullary arachnoid cyst: case report and literature review. World Neurosurgery, v. 138, p. 68-72, 2020. DOI: 10.1016/j.wneu.2020.02.106.

15. INOUYE, J. et al. Diagnosis and Surgical Treatment of Thoracic Dorsal Arachnoid Web: A Report of Two Cases. Case Reports in Orthopedics, 2020. DOI: 10.1155/2020/8816598.

16. KIM, K.S.; WEINBERG, P.E. Magnetic resonance imaging of a spinal extradural arachnoid cyst. Surgical Neurology, v. 26, n. 3, p. 249-252, 1986.

17. KRINGS, T. et al. Diagnostic and therapeutic management of spinal arachnoid cysts. Acta Neurochirurgica, v. 143, n. 3, p. 227-235, 2001.

18. OGURA, Y. et al. FOXC2 mutations in familial and sporadic spinal extradural arachnoid cyst. PLoS ONE, v. 8, n. 11, e80548, 2013.

19. PARAMORE, C.G. Dorsal arachnoid web with spinal cord compression: variant of an arachnoid cyst? Journal of Neurosurgery, v. 93, n. 2 Suppl, p. 287-290, 2000. DOI: 10.3171/spi.2000.93.2.0287.

20. PAULSEN, R.D.; CALL, G.A.; MURTAGH, F.R. Prevalence and percutaneous drainage of cysts of the sacral nerve root sheath (Tarlov cysts). AJNR American Journal of Neuroradiology, v. 15, n. 2, p. 293-297, 1994.

21. RABB, C.H. et al. Spinal arachnoid cysts in the pediatric age group: an association with neural tube defects. Journal of Neurosurgery, v. 77, n. 3, p. 369-372, 1992.

22. SANGALA, J.R. et al. Nerve root prolapse into a spinal arachnoid cyst–an unusual cause of radiculopathy. Clinical Neurology and Neurosurgery, v. 111, n. 5, p. 460-464, 2009.

23. SPIEGELMANN, R.; RAPPAPORT, Z.H.; SAHAR, A. Spinal arachnoid cyst with unusual presentation. Journal of Neurosurgery, v. 60, n. 3, p. 613-616, 1984.

24. VERGARA, P.; BARONE, D.G. Minimally invasive excision of thoracic arachnoid web. World Neurosurgery, v. 109, p. e81-e87, 2018. DOI: 10.1016/j.wneu.2017.09.107.

25. ZHANG, D.; PAPAVASSILIOU, E. Spinal intradural arachnoid webs causing spinal cord compression with inconclusive preoperative imaging: a report of 3 cases and a review of the literature. World Neurosurgery, v. 99, p. 251-258, 2017.