

## Original Article

## Vastus medialis injury by indirect mechanism in football, a case series

Oscar Vicente<sup>a,\*</sup>, Carles Pedret<sup>b</sup>, Olga Velasco<sup>a,c,d</sup><sup>a</sup> Department of Nursing and Physiotherapy, University of the Balearic Islands (UIB), Palma, Spain<sup>b</sup> Clínica Diagonal, Barcelona, Spain<sup>c</sup> Research Institute of Health Sciences (IUNICS) University of the Balearic Islands (UIB), Palma, Spain<sup>d</sup> Health Research Institute of the Balearic Islands, Spain

## ARTICLE INFO

## Keywords:

Vastus medialis  
Magnetic resonance imaging  
BAMIC  
Muscle injury  
Football injury

## ABSTRACT

**Introduction:** To our knowledge, indirect mechanism injuries of the Vastus medialis (VM) are still not reported in literature. The aim of this case series study is to describe indirect mechanism VM injuries in football, suggest the best clinical assessment, imaging tests and guidelines for a safe return-to-play (RTP).

**Materials and methods:** Over a period of 3 years, four professional football players diagnosed with VM injury by indirect mechanism, were included in the series. Magnetic resonance imaging (MRI) was performed to control the injuries evolution.

**Results:** In this series, Myofascial injuries presented higher frequency and shorter RTP time (16 days mean) than myotendinous injury (26 days). Two injury mechanisms were identified: Deceleration and progressive loading.

**Conclusion:** The VM is a muscle that can also be injured by indirect mechanism. These are a good prognosis injury, if managed correctly, as they are clinically well tolerated injuries. The series findings should be taken wisely, requiring further sampling and studies.

## Introduction

The quadriceps muscle complex is one of the most injured muscle groups in sports<sup>1</sup> especially if we speak about the rectus femoris (RF) muscle.

Injuries affecting the vastus medialis (VM) muscle are scarcely reported in literature and usually in relation to contusion injuries.<sup>2,3</sup>

To our knowledge, indirect mechanism injuries of the VM are still not reported in literature. The aim of this case series study is to describe indirect mechanism VM injuries in football, suggest the best clinical assessment, imaging tests and guidelines for a safe return-to-play (RTP).

## Anatomy and function of the vastus medialis

The anatomical structure of the VM muscle, (Fig. 1A.<sup>4</sup> B<sup>5</sup>), is complex due to its location and architecture.<sup>6</sup> The origin area extends from the inferior zone of the intertrochanteric line, the spiral line and the medial lip of the linea aspera to the medial femoral supracondylar line.

As the muscle increase in volume, it forms on its posterior aspect the

medial aponeurosis of the VM, intimately related to the adductor longus aponeurosis and Hunter's canal.

The insertion is divided into three sections<sup>7,8</sup>:

- Proximally into the aponeurosis of the vastus intermedius (VI).
- In the middle third, into the insertion tendon of the rectus femoris (RF).
- Distal section directly to the medial border of the patella and the joint capsule.

Its function is defined according two perspectives. Some authors<sup>9</sup> suggest a division into two independent parts, Vastus medialis oblique (distal fibers), which act to medially stabilize the patella, and Vastus medialis longus<sup>10</sup> (remaining fibers), which generate extensor forces only. Other studies<sup>11</sup> concluded that the VM behaves as a whole, multiple muscle units in cooperation with the VI adjusting knee extension, pulling medially the patella and keeping medial-lateral balance, without independence of its fibers.

\* Corresponding author.

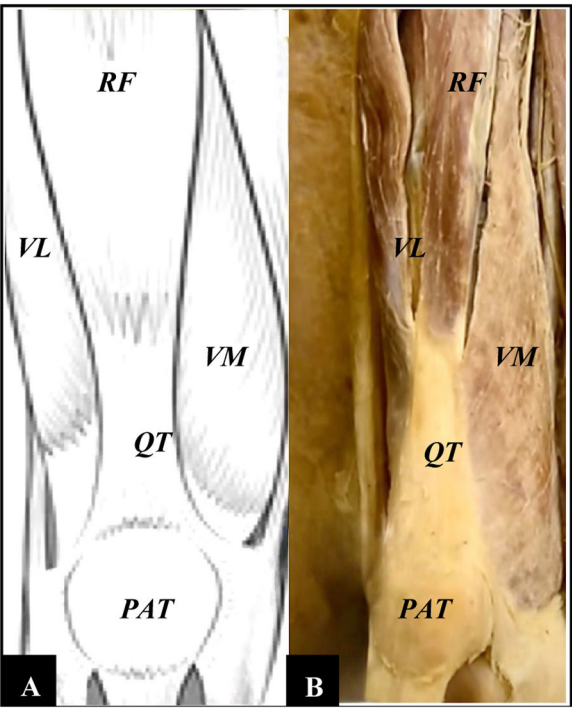
E-mail address: [ovrodriguez@atleticodemadrid.com](mailto:ovrodriguez@atleticodemadrid.com) (O. Vicente).

<https://doi.org/10.1016/j.apunsm.2025.100487>

Received 15 March 2025; Accepted 4 April 2025

Available online 25 April 2025

2666-5069/© 2025 Published by Elsevier España, S.L.U. on behalf of Consell Català de l'Esport. This is an open access article under the CC BY-NC-ND license (<http://creativecommons.org/licenses/by-nc-nd/4.0/>).



**Fig. 1.** A Thigh anatomical model. B. Thigh anatomical dissection. VM (vastus medialis), VL (vastus lateralis), RF (rectus femoris), QT (quadriceps tendon), PAT (patella).

Materials and methods

Four professional football players, belonging to the same club, who presented pain in the medial anterior aspect of the thigh during their sport activity, (training and matches) and diagnosed with VM injury between January 2020 and May 2023 were included in the study (Table 1). VM injuries caused by direct trauma (contusions and lacerations) were excluded.

After 24 h of the injury event diagnosis was performed clinically with palpation, passive and active stretching, looking for the pain area. Imaging diagnosis, was made within 3 days, by Magnetic Resonance Imaging (MRI) General Electrics Optima MR450W 1.5T confirmed the VM injury classified according to the BAMIC scale.<sup>12</sup> All injuries were managed in a standard way, based on the clinical practice guideline for muscle injuries published in 2018 by Futbol Club Barcelona.<sup>13</sup> Return to play (RTP) times and reinjuries, were recorded in the club database until January 2023.

**Table 1**  
Players characteristics (n = 4).

| Case | Age | Position   | Dominant Leg | Injured Leg | Injury Mechanism |
|------|-----|------------|--------------|-------------|------------------|
| 1    | 31  | Defender   | Right        | Right       | Deceleration     |
| 2    | 24  | Midfielder | Left         | Right       | Progressive Load |
| 3    | 32  | Goalkeeper | Left         | Left        | Deceleration     |
| 4    | 25  | Midfielder | Left         | Left        | Progressive Load |

**Table 2**  
MRI Findings & RTP time (\*reinjury RTP).

| Case | Radiological findings & histoarchitecture |               |                 |          |          | Injury Clasif<br>BAMIC | Return to Play |          |
|------|---|---------------|-----------------|----------|----------|------------------------|----------------|----------|
|      | MTJ implicate                             | MFJ implicate | Loss of tension | Hematoma | Fibrosis |                        | RTP days       | Reinjury |
| 1    | Distal                                    | Distal        | No              | Yes      | Yes      | 2A                     | 18/21*         | Yes      |
| 2    |   |               | No              | No       | No       | 1B                     | 26             | No       |
| 3    |   | Distal        | No              | No       | No       | 2A                     | 14             | No       |
| 4    |   | Proximal      | No              | No       | No       | 2A                     | 17             | No       |

Results

From the 4 cases of VM injury (Table 2): Case 1 (Fig. 2A,B), case 3 (Fig. 3A,B), and case 4 (Fig. 4A,B) suffered myofascial junction (MFJ) involvement, all of them were classified as type 2A injuries according to BAMIC. There was only one rupture of myotendinous junction (MTJ), case 2 (Fig. 5A,B), which was classified as type 1B

The mean RTP time of all VM injuries were 19 days (range 0–26). Specifically, it was 16 days (range 14–21) for myofascial injuries, and 26 days for myotendinous injury (Table 2). During the three years of the study, only one reinjury occurred, case 1, which required 21 days for RTP in the second injury episode.

Discussion

One of the main findings of the study is to highlight the most frequently injured regions in the VM, the myofascial junctions, case 1 (Fig. 2A,B). In relation to the symptoms, all cases presented pain on palpation and tightness in the region between the VM and sartorius. It is important to make a differential diagnosis with an injury to the sartorius muscle which was also one of the muscles involved in the clinical assessment.

Two injuries mechanisms were identified:

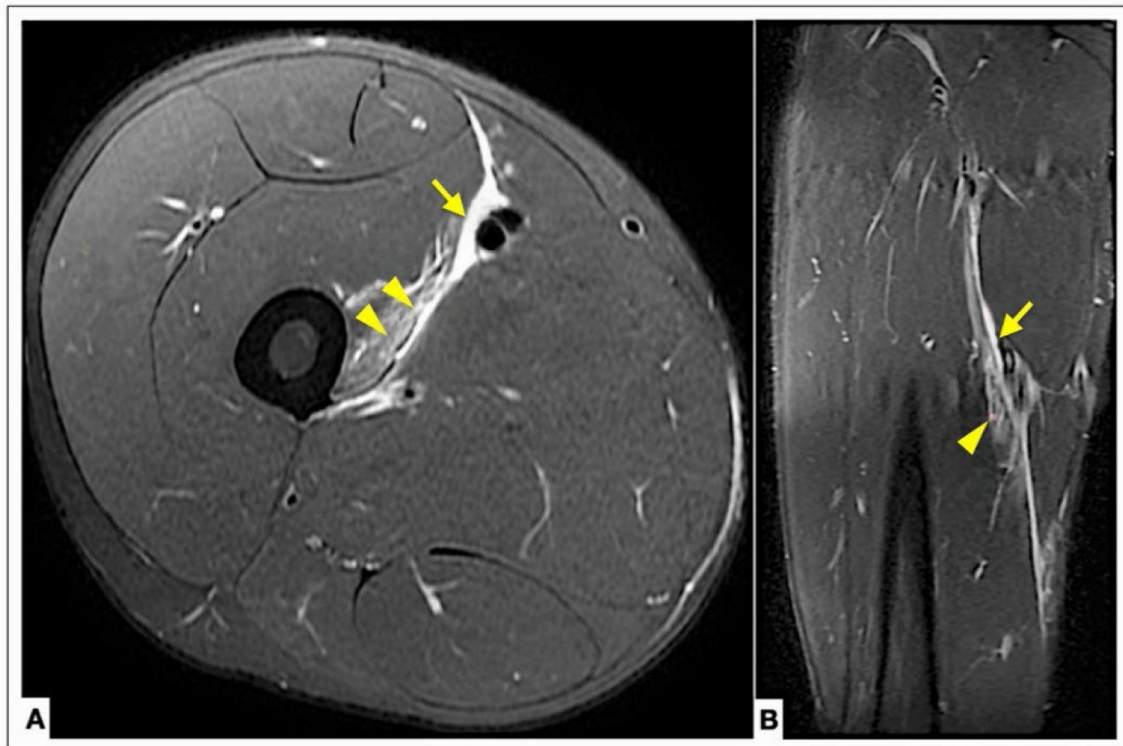
- Deceleration. Several studies<sup>14–16</sup> confirmed the implication of the VM in the braking phase during running this was the mechanism observed in cases 1 and 3.
- Progressive overloading of the VM. This is the second observed injury mechanism, much more unspecific but the one observed in cases 2 and 4. When we speak about the progressive overload of the muscle, the anatomical location of the VM implies a high degree of interaction and cooperation<sup>8,17</sup> with its adjacent muscles, this is probably the reason why VM injuries might be simultaneous with of other muscles, as shown in the MRI findings in case 3 (Fig. 3A,B), where there is involvement of the adductor longus and adductor magnus and also in case 4 (Fig. 4A,B), where the VM defect is related to an RF injury.

It is relevant to mention that in none of the cases, kicking, the most frequent mechanism in quadriceps injuries<sup>18</sup> was not limited by pain, since the involvement of the VM in kicking is not significant.<sup>19</sup>

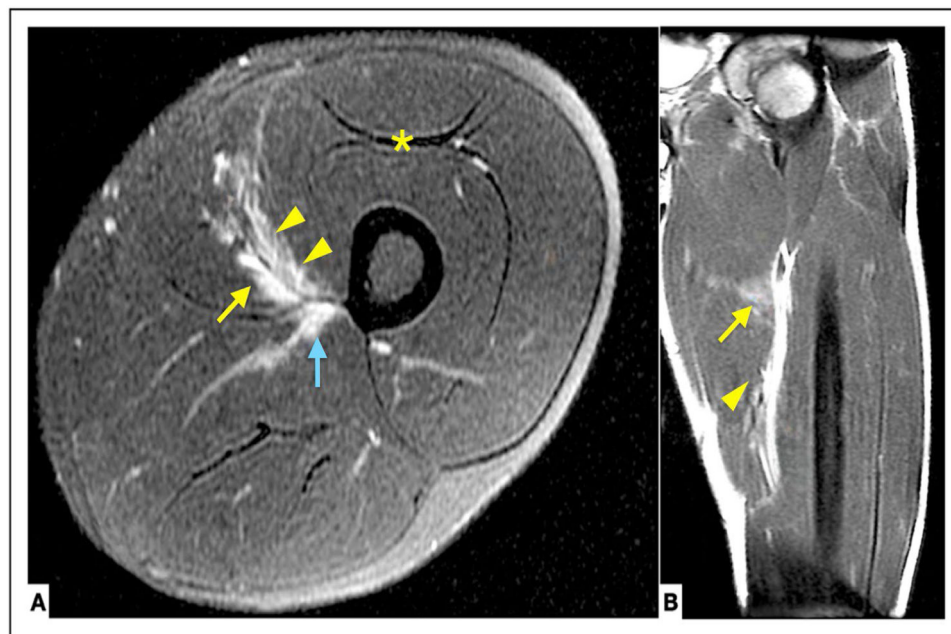
In terms of diagnosis, MRI is considered the gold standard in VM injuries. This fact is due to the depth and anatomical disposition of the muscle through the planes, which makes it difficult to quantify the extension of the affected tissue<sup>20</sup> for other techniques such as ultrasound that can be useful in monitoring the evolution.

Speaking about classifying these injuries, the classification system that we used was the BAMIC classification,<sup>12</sup> the same used by the radiologist in his reports and the most widely used in sports. From our point of view, other classifications such as the MLG-R Classification<sup>21</sup> could also be feasible within the specific nomenclature according to the location of the injuries, MFJ and MTJ.

Regarding specific treatment, it is suggested to monitor the appearance of an intermuscular hematoma (this could be done by ultrasound). In case of a significant hematoma, we recommend its ultrasound guided drainage in order to avoid a poorly adapted hypertrophic laminar scar.<sup>22</sup>



**Fig. 2. Case 1.** Distal myofascial injury 2A (BAMIC) in the VM. **A** Axial T2 Fat-sat section. **B** Coronal T2 Fat-sat section. Arrowheads (*Interstitial edema in the VM*), Arrow (*hematoma Hunter's canal*). MRI evidence of myofascial damage surrounding the deep area of the VM. Exist also a minimal hematoma located posterior to the sartorius muscle, it was a challenge for the clinical evolution: It initially compressed the Hunter's canal and increased the sensitivity of the area, subsequently produced a hypertrophic laminar scar and reinjury after one month.



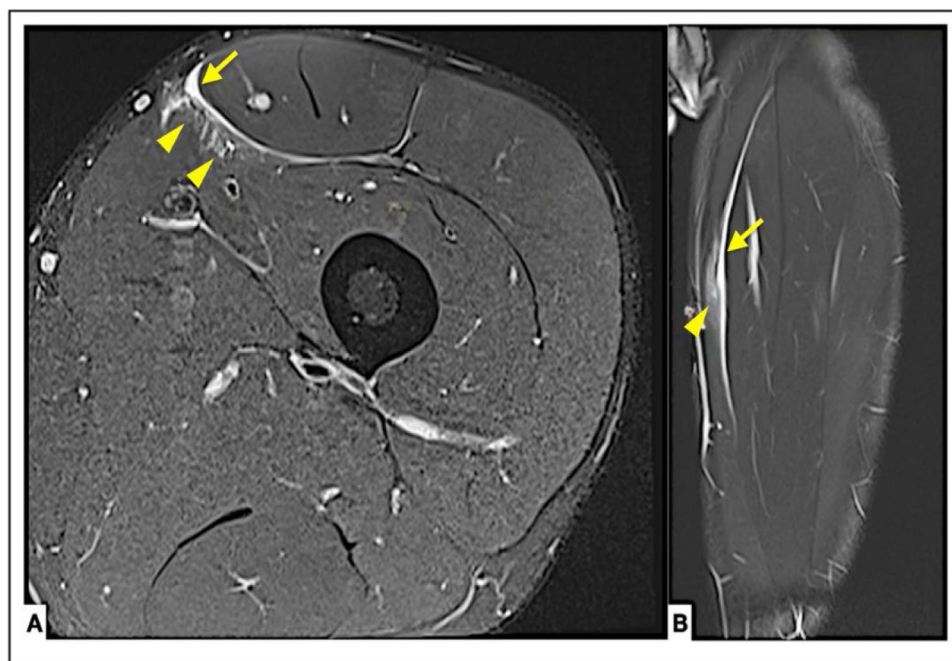
**Fig. 3. Case 3.** Distal myofascial injury 2A (BAMIC) in the VM. **A** Axial T2 Fat-sat section. **B** Coronal T2 Fat-sat section. Arrowheads (*Interstitial edema in the VM*), Yellow arrow (*Edema in the AL*), Blue arrow (*Edema in the AM*), Asterisk (*Old scar Posterior Ap. RF, relevant to the discussion*). The interstitial edema in the VM is similar to case 1, additionally, it extends within the adductor longus (AL) and adductor magnus (AM) with evidence of both damages.

In this case series, none of the cases developed a significant hematoma but we need to consider this option as a possibility due to the anatomical characteristics of these injuries.

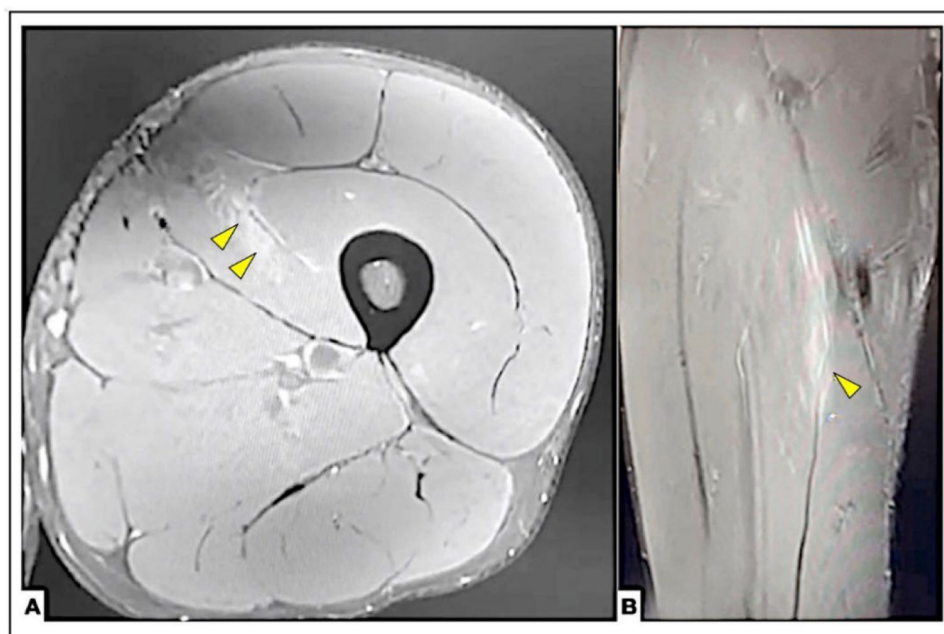
Treatment is always conservative<sup>23</sup> with physiotherapy treatment with correct and adapted exercise progression. Physiotherapy

recommendations include a sliding work of the planes by different strategies: Diathermy and active tension stretching, also the use of neural mobilization techniques could help to normalize the sensitivity of the area due to the proximity of the femoral vessels and nerves.





**Fig. 4.** Case 4. Proximal myofascial injury 2A (BAMIC) in the VM. **A** Axial T2 Fat-sat section. **B** Coronal T2 Fat-sat section. Arrowheads (*Interstitial edema in the VM*), Arrow (*hematic collection in relation to posterior fascia RF injury*). In this case the damage is located in the proximal MFJ of the VM, in relation to an acute injury of RF posterior fascia, that by extension, reaches the most anterior fibers of the VM.



**Fig. 5.** Case 2. Distal myotendinous injury 1B (BAMIC) in the VM. **A** Axial T2 Fat-sat section. **B** Coronal T2 Fat-sat section. Arrowheads (*Edema in the insertional aponeurosis of the VM in the VI*). This is the only myotendinous injury in this series, it affects the distal MTJ, at the insertion tract of the VM into the VI.

## Conclusion

The VM is a muscle that can also be injured by indirect mechanism. These are a good prognosis injury, if managed correctly, as they are clinically well tolerated injuries. In our series, myofascial injuries present shorter RTP time (16 days mean) than myotendinous injury (26 days).

## Limitations

The findings of this case series must be taken wisely due to the limitations of the study:

- Small sample size.
- Retrospective design.
- The literature and research regarding VM is lacking, and the injury incidence is very low.

However, this is the first study to present a case series of VM injuries in football players, and could be the starting point for future research with more representative samples, in other sports disciplines, in order to compare the results with this case series in football.

## Conflicts of interest

The authors declare that there is no conflict of interest in relation to this case series. About data confidentiality there is an informed consent document from the participants.

## References

- Ekstrand J, Häggglund M, Waldén M. Epidemiology of muscle injuries in professional football (soccer). *Am J Sports Med.* 2011;39(6):1226–1232. <https://doi.org/10.1177/0363546510395879>. JunConsultado/citado, según normativa VancouverEpub 2011 Feb 18. PMID: 21335353.
- Lempainen L, Mechó S, Valle X, Mazzoni S, Villalon J, Freschi M, Stefanini L, García-Romero-Pérez A, Burova M, Pleshkov P, Pruna R, Pasta G, Kosola J. Management of anterior thigh injuries in soccer players: practical guide. *BMC Sports Sci Med Rehabil.* 2022;14(1):41. <https://doi.org/10.1186/s13102-022-00428-y>. Mar 18Consultado/citado, según normativa VancouverPMID: 35303927; PMCID: PMC8932115.
- Eliceigui S, Stovak M, Dobrich J, Hodges JJ, Sekhon V, Dolan C. Traumatic mid-substance isolated vastus medialis rupture in a young athlete: a case report. *JBJS Case Connect.* 2023;13(4). <https://doi.org/10.2106/JBJS.CC.23.00422>. Dec 22Consultado/citado, según normativa VancouverPMID: 38134302.
- Szunyoghy A, Feher G. Anatomía humana para artistas. Editorial Könemann, Colonia, 2006.
- UBC Medicine 2020 FLEX Team. Anterior and medial thigh anatomy [Video de Internet]. Youtube. 2018. [Cited February 15, 2025]. Available at: [https://www.youtube.com/watch?v=4l\\_UJ3qht08](https://www.youtube.com/watch?v=4l_UJ3qht08).
- Balius R, Pedret C. Lesiones musculares en el deporte. Editorial médica panamericana, Madrid, 2005.
- Driscoll P. Gray's Anatomy, 39th edition. *Emerg Med J.* 2006;23(6):492. <https://doi.org/10.1136/emj.2005.027847>. JunConsultado/citado, según normativa VancouverPMID: 2564372.
- Grob K, Manestar M, Filgueira L, Kuster MS, Gilbey H, Ackland T. The interaction between the vastus medialis and vastus intermedius and its influence on the extensor apparatus of the knee joint. *Knee Surg Sports Traumatol Arthrosc.* 2018;26(3):727–738. <https://doi.org/10.1007/s00167-016-4396-3>. MarConsultado/citado, según normativa VancouverEpub 2017 Jan 25. PMID: 28124107.
- Lefebvre R, Leroux A, Poumarat G, Galtier B, Guillot M, Vanneuville G, Boucher JP. Vastus medialis: anatomical and functional considerations and implications based upon human and cadaveric studies. *J Manipulative Physiol Ther.* 2006;29(2):139–144. <https://doi.org/10.1016/j.jmpt.2005.12.006>. FebConsultado/citado, según normativa VancouverPMID: 16461173.
- Bose K, Kanagasuntheram R, Osman MB. Vastus medialis oblique: an anatomic and physiologic study. *Orthopedics.* 1980;3(9):880–883. <https://doi.org/10.3928/0147-7447-19800901-12>. Sep 1Consultado/citado, según normativa VancouverPMID: 24822568.
- Peeler J, Cooper J, Porter MM, Thliveris JA, Anderson JE. Structural parameters of the vastus medialis muscle. *Clin. Anat.*, 2005;18:281–289. <https://doi.org/10.1002/ca.20110>. Consultado/citado, según normativa Vancouver.
- Pollock N, James SL, Lee JC, Chakraverty R. British athletics muscle injury classification: a new grading system. *Br J Sports Med.* 2014;48(18):1347–1351. <https://doi.org/10.1136/bjsports-2013-093302>. SepConsultado/citado, según normativa VancouverEpub 2014 Jul 16. PMID: 25031367.
- Capabiliaserver.Com. 2019. [Cited April 28, 2024]. Available at: <https://static.capabiliaserver.com/frontend/clients/barca/wp/wp-content/uploads/2019/03/105e3b07-muscle-guide-general-principles-of-return-to-play-from-muscle-injury.pdf>.
- Ellis RG, Sumner BJ, Kram R. Muscle contributions to propulsion and braking during walking and running: insight from external force perturbations. *Gait Posture.* 2014;40(4):594–599. <https://doi.org/10.1016/j.gaitpost.2014.07.002>. SepConsultado/citado, según normativa VancouverEpub 2014 Jul 10. PMID: 25096545.
- Hamner SR, Seth A, Delp SL. Muscle contributions to propulsion and support during running. *J Biomech.* 2010;43(14):2709–2716. <https://doi.org/10.1016/j.jbiomech.2010.06.025>. Oct 19Consultado/citado, según normativa VancouverEpub 2010 Aug 9. PMID: 20691972; PMCID: PMC2973845.
- Sasaki K, Neptune RR. Differences in muscle function during walking and running at the same speed. *J Biomech.* 2006;39(11):2005–2013. <https://doi.org/10.1016/j.jbiomech.2005.06.019>. Consultado/citado, según normativa VancouverEpub 2005 Aug 29. PMID: 16129444.
- Bergstrom HC, Housh TJ, Dinyer TK, Byrd TM, Jenkins NDM, Cochrane-Snyman KC, Succi PJ, Schmidt RJ, Johnson GO, Zuniga JM. Neuromuscular responses of the superficial quadriceps femoris muscles: muscle specific fatigue and inter-individual variability during severe intensity treadmill running. *J Musculoskelet Neuronal Interact.* 2020;20(1):77–87. Mar 3Consultado/citado, según normativa Vancouver PMID: 32131371; PMCID: PMC7104590.
- Jokela A, Mechó S, Pasta G, Pleshkov P, García-Romero-Pérez A, Mazzoni S, Kosola J, Vittadini F, Yanguas J, Pruna R, Valle X, Lempainen L. Indirect rectus Femoris injury mechanisms in professional soccer players: video analysis and magnetic resonance imaging findings. *Clin J Sport Med.* 2023;33(5):475–482. <https://doi.org/10.1097/JSM.0000000000001131>. Sep 1Consultado/citado, según normativa VancouverEpub 2023 Feb 28. PMID: 36853900; PMCID: PMC10467807.
- Singh Ram, Singh Vikram, Ram Mr, Yadav Singh. Emg analysis of quadriceps muscles groups during kicking in football. *JMESS.* 2017;6(1). March2278-0793Consultado/citado, según normativa Vancouver.
- Isern-Kebschull J, Mechó S, Pruna R, et al. Sports-related lower limb muscle injuries: pattern recognition approach and MRI review. *Insights Imaging.* 2020;11:108. <https://doi.org/10.1186/s13244-020-00912-4>. Consultado/citado, según normativa Vancouver.
- Valle X, Alentorn-Geli E, Tol JL, Hamilton B, Garrett Jr WE, Pruna R, Til L, Gutierrez JA, Alomar X, Balius R, Malliaropoulos N, Monllau JC, Whiteley R, Witvrouw E, Samuelsson K, Rodas G. Muscle injuries in sports: a new evidence-informed and expert consensus-based classification with clinical application. *Sports Med.* 2017;47(7):1241–1253. <https://doi.org/10.1007/s40279-016-0647-1>. JulConsultado/citado, según normativa VancouverPMID: 27878524.
- Pedret Carles, Balius Ramon. Lesiones musculares en el deporte. Actualización de un artículo del Dr. Cabot, publicado en Apuntes de Medicina Deportiva en 1965. *Apuntes. Medicina de l'Esport.* 2015;50, 10.1016 Consultado/citado, según normativa Vancouver j.apunts.2015.01.005.
- Study Group of the Muscle and Tendon System from the Spanish Society of Sports Traumatology, Balius R, Blasi M, Pedret C, Alomar X, Peña-Amaro J, Vega JA, Pruna R, Ardèvol J, Álvarez G, de la Fuente J, Fernández-Jaén T, Järvinen TAH, Rodas G. A histoarchitectural approach to skeletal muscle injury: searching for a common nomenclature. *Orthop J Sports Med.* 2020;8(3), 2325967120909090. <https://doi.org/10.1177/2325967120909090>. Mar 20Consultado/citado, según normativa VancouverPMID: 32232071; PMC.