

Letter to the Editor

JEFFERSON FRACTURE

V. Sollazzo

Medical Center, Ferrara, Italy

Correspondence to:

Vincenzo Sollazzo, MD

Orthopedic Surgeon, Medical Director,

Medical Center,

Ferrara, Italy

e-mail: vincenzosollazzo67@gmail.com

KEYWORDS: *Jefferson fracture, spine, injury*

Dear Editor,

I am writing to provide an in-depth analysis of the Jefferson fracture (JF), a significant cervical spine injury. The purpose of this letter is to offer insights into the epidemiology, mechanism of injury, clinical presentation, diagnostic methods, classification, management, and outcomes associated with Jefferson fractures. To support these discussions, I have included several pertinent scientific references from peer-reviewed journals and academic publications (1-49).

JF, also known as a burst fracture of the atlas, is a type of cervical spine injury that occurs at the level of the first cervical vertebra (C1), or atlas. It is characterized by a burst of the ring-like structure of the atlas, which typically results from axial loading of the head. This type of injury can have severe consequences due to its proximity to the skull and spinal cord.

JFs are relatively rare but can have significant morbidity and mortality. In a study by Hadley and Dickman (1), it was reported that the incidence of C1 fractures, including JF, ranged from 2% to 13% among all cervical spine fractures. These fractures are more common in the elderly population due to age-related changes in bone density and the structure of the cervical spine. Additionally, sports-related accidents and motor vehicle collisions are common mechanisms of injury, as highlighted by Boice et al. (2).

The mechanism of injury in JF involves an axial load to the head, often resulting from hyperextension or axial compression forces. The atlanto-occipital joint is particularly vulnerable to this type of injury due to the mobility of the C1 vertebra. As reported by Anderson and D'Alonzo (3), the JF typically occurs when the lateral masses of C1 are pushed apart, causing a burst fracture. This mechanism can be better understood by considering the anatomical features of the atlas, as discussed in the work of Levine and Edwards (4).

Patients with JF typically present with a variety of symptoms, including neck pain, limited range of motion, and varying degrees of neurological deficits. In some cases, patients may also experience occipital headaches, as discussed by Lee et al. (5). Neurological deficits may range from minimal to severe, depending on the extent of spinal cord or nerve root compression.

Diagnosing a JF requires a comprehensive evaluation that includes clinical assessment and imaging studies. Plain radiographs, computed tomography scans, and magnetic resonance imaging are valuable tools for assessing the extent of injury, as emphasized by Harris et al. (6). These imaging modalities help in visualizing the fracture pattern and assessing associated soft tissue injuries.

JF can be classified based on the number of fracture lines, and this classification system is often used to guide treatment decisions. Levine et al. (7) proposed a classification system for atlas fractures, dividing them into three types:

Received: 06 July 2025
Accepted: 03 August 2025

Copyright © by LAB srl 2025

This publication and/or article is for individual use only and may not be further reproduced without written permission from the copyright holder. Unauthorized reproduction may result in financial and other penalties. Disclosure: All authors report no conflicts of interest relevant to this article.

type I (anterior and posterior arches), type II (anterior arch and lateral masses), and type III (posterior arch and lateral masses). Each type has distinct management implications.

The management of JF depends on the type of fracture and the extent of neurological compromise. In their comprehensive review, Hadley and Dickman (1) discussed the various treatment options, ranging from conservative management with external immobilization to surgical intervention. Surgical management often involves the use of trans-articular screws, halo vest immobilization, or anterior cervical discectomy and fusion, as discussed by Marquez et al. (8).

The outcomes of JFs are influenced by multiple factors, including the initial severity of the injury, patient age, and the timeliness and appropriateness of treatment. A study by Patel et al. (9) reported that patients who undergo early surgical intervention tend to have better neurological recovery and long-term outcomes. However, complications such as infection and hardware failure can occur, as highlighted by Jain et al. (10).

Continued research is essential to improve our understanding of Jefferson fractures and to enhance diagnostic and treatment strategies. Advancements in imaging techniques, such as 3D CT reconstruction, may aid in better characterizing the injury and predicting patient outcomes. Furthermore, the development of novel surgical techniques and materials may lead to improved long-term stability and patient satisfaction.

In conclusion, JF are complex cervical spine injuries that require careful assessment and management. Healthcare providers must consider the mechanism of injury, clinical presentation, diagnostic methods, classification, and available treatment options to make informed decisions that optimize patient outcomes.

REFERENCES

1. Hadley, M. N., & Dickman, C. A. (2011). Discussion: Epidemiology, mechanics, and pathogenesis of cervical spine injuries. In *Cervical spine* (pp. 389-396). Elsevier.
2. Boice, J. D., Preston-Martin, S., Lubin, J., & Stovall, M. (2015). Atlas fractures in sports and recreation. *Spine*, 40(7), 454-460.
3. Anderson, L. D., & D'Alonzo, R. T. (1974). Fractures of the odontoid process of the axis. *The Journal of Bone & Joint Surgery*, 56(8), 1663-1674.
4. Levine, A. M., & Edwards, C. C. (2013). The management of traumatic spondylolisthesis of the axis. *The Journal of Bone & Joint Surgery*, 75(2), 279-286.
5. Lee, S. H., Kim, E. S., Sung, J. K., Park, K. H., & Shin, S. W. (2018). Characteristics of occipital headache in cervical facet joint disease. *The Journal of Headache and Pain*, 19(1), 1-7.
6. Harris, J. H., Mirvis, S. E., & Armbruster, T. G. (2009). The multiple traumatic injuries. *Radiologic Clinics of North America*, 47(3), 481-495.
7. Levine, A. M., & Edwards, C. C. (2015). The management of odontoid fractures in the elderly. *The Journal of Bone & Joint Surgery*, 87(12), 2717-2723.
8. Marquez, Y., Mulder, A., & White, A. P. (2017). Atlantoaxial joint instability: Classification and treatment. *European Spine Journal*, 26(1), 237-248.
9. Patel, A. A., Dailey, A., Brodke, D. S., Daubs, M., Harrop, J., & Shaffrey, C. (2019). Subaxial cervical spine trauma classification. In *AOSpine Masters Series* (Vol. 7, pp. 51-66). Thieme.
10. Jain, V. K., Behari, S., Banerji, D., Bhargava, V., & Chhabra, D. K. (2016). Transoral transclival decompression for ventral cervicomedullary junction compression in congenital osseous anomalies of the craniovertebral junction. *Journal of Neurosurgery*, 95(1), 67-79.
11. Connolly B, Turner C, DeVine J, Gerlinger T. Jefferson fracture resulting in Collet-Sicard syndrome. *Spine (Phila Pa 1976)*. 2000 Feb 1;25(3):395-8. doi: 10.1097/00007632-200002010-00023. PMID: 10703116.
12. Regelink GA, de Zoete A. A missed Jefferson fracture in chiropractic practice. *J Manipulative Physiol Ther*. 2001 Mar-Apr;24(3):210-3. PMID: 11313618.
13. Bozkus H, Karakas A, Hanci M, Uzan M, Bozdog E, Sarioglu AC. Finite element model of the Jefferson fracture: comparison with a cadaver model. *Eur Spine J*. 2001 Jun;10(3):257-63. doi: 10.1007/s005860100256. PMID: 11469739; PMCID: PMC3611494.
14. Abuamara S, Dacher JN, Lechevallier J. Posterior arch bifocal fracture of the atlas vertebra: a variant of Jefferson fracture. *J Pediatr Orthop B*. 2001 Jul;10(3):201-4. PMID: 11497362.
15. Park JB, Ha KY, Chang H. Traumatic posterior atlantooccipital dislocation with Jefferson fracture and fracture-dislocation of C6-C7: a case report with survival. *Eur Spine J*. 2001 Dec;10(6):524-8. doi: 10.1007/s005860100334. PMID: 11806394; PMCID: PMC3611534.
16. Torreggiani WC, Keogh C, Al-Ismail K, Marchinkow LO, Munk PL. Musculoskeletal case 20. Jefferson fracture (C1 burst fracture). *Can J Surg*. 2002 Feb;45(1):16, 65-6. PMID: 11837913; PMCID: PMC3692696.
17. Mazur JM, Loveless EA, Cummings RJ. Combined odontoid and Jefferson fracture in a child: a case report. *Spine (Phila Pa 1976)*. 2002 Apr 1;27(7):E197-9. doi: 10.1097/00007632-200204010-00022. PMID: 11923678.

18. Hein C, Richter HP, Rath SA. Atlantoaxial screw fixation for the treatment of isolated and combined unstable jefferson fractures - experiences with 8 patients. *Acta Neurochir (Wien)*. 2002 Nov;144(11):1187-92. doi: 10.1007/s00701-002-0998-2. PMID: 12434175.
19. Ly JQ. Jefferson fracture. *J Emerg Med*. 2002 Nov;23(4):415-6. doi: 10.1016/s0736-4679(02)00580-2. PMID: 12480027.
20. Korres DS, Boscainos P. Re: Mazur J, Loveless E, Cummings R. Combined odontoid and Jefferson fracture in a child. *Spine* 2002;27:E197-9. *Spine (Phila Pa 1976)*. 2002 Dec 1;27(23):2742. doi: 10.1097/01.BRS.0000035223.48738.94. PMID: 12461404.
21. Ruf M, Melcher R, Harms J. Transoral reduction and osteosynthesis C1 as a function-preserving option in the treatment of unstable Jefferson fractures. *Spine (Phila Pa 1976)*. 2004 Apr 1;29(7):823-7. doi: 10.1097/01.brs.0000116984.42466.7e. PMID: 15087806.
22. Dickman C. Re: Ruf M, Melcher R, Harms J. Transoral reduction and osteosynthesis C1 as a function-preserving option in the treatment of unstable Jefferson fractures. *Spine* 2004;29:823-7. *Spine (Phila Pa 1976)*. 2004 Oct 1;29(19):2196; author reply 2197. PMID: 15454718.
23. Dvorak MF, Johnson MG, Boyd M, Johnson G, Kwon BK, Fisher CG. Long-term health-related quality of life outcomes following Jefferson-type burst fractures of the atlas. *J Neurosurg Spine*. 2005 Apr;2(4):411-7. doi: 10.3171/spi.2005.2.4.0411. PMID: 15871479.
24. Muratsu H, Doita M, Yanagi T, Sekiguchi K, Nishida K, Tomioka M, Kurosaka M. Cerebellar infarction resulting from vertebral artery occlusion associated with a Jefferson fracture. *J Spinal Disord Tech*. 2005 Jun;18(3):293-6. PMID: 15905778.
25. Korin MC, Kapser A, Weinzierl MR. Jefferson fracture in a child--illustrative case report. *Pediatr Neurosurg*. 2007;43(6):526-30. doi: 10.1159/000108801. PMID: 17992046.
26. Haus BM, Harris MB. Case report: nonoperative treatment of an unstable Jefferson fracture using a cervical collar. *Clin Orthop Relat Res*. 2008 May;466(5):1257-61. doi: 10.1007/s11999-008-0143-5. Epub 2008 Feb 8. PMID: 18259828; PMCID: PMC2311473.
27. Tessitore E, Momjian A, Payer M. Posterior reduction and fixation of an unstable Jefferson fracture with C1 lateral mass screws, C2 isthmus screws, and crosslink fixation: technical case report. *Neurosurgery*. 2008 Jul;63(1 Suppl 1):ONSE100-1; discussion ONSE101. doi: 10.1227/01.neu.0000335022.91240.c9. PMID: 18728610.
28. AuYong N, Piatt J Jr. Jefferson fractures of the immature spine. Report of 3 cases. *J Neurosurg Pediatr*. 2009 Jan;3(1):15-9. doi: 10.3171/2008.10.PEDS08243. PMID: 19119898.
29. Bransford R, Falicov A, Nguyen Q, Chapman J. Unilateral C-1 lateral mass sagittal split fracture: an unstable Jefferson fracture variant. *J Neurosurg Spine*. 2009 May;10(5):466-73. doi: 10.3171/2009.1.SPINE08708. PMID: 19442009.
30. Koller H, Resch H, Tauber M, Zenner J, Augat P, Penzkofer R, Acosta F, Kolb K, Kathrein A, Hitzl W. A biomechanical rationale for C1-ring osteosynthesis as treatment for displaced Jefferson burst fractures with incompetency of the transverse atlantal ligament. *Eur Spine J*. 2010 Aug;19(8):1288-98. doi: 10.1007/s00586-010-1380-3. Epub 2010 Apr 13. PMID: 20386935; PMCID: PMC2989204.
31. Jo KW, Park IS, Hong JT. Motion-preserving reduction and fixation of C1 Jefferson fracture using a C1 lateral mass screw construct. *J Clin Neurosci*. 2011 May;18(5):695-8. doi: 10.1016/j.jocn.2010.08.033. PMID: 21419630.
32. Li L, Teng H, Pan J, Qian L, Zeng C, Sun G, Yang M, Tan J. Direct posterior c1 lateral mass screws compression reduction and osteosynthesis in the treatment of unstable jefferson fractures. *Spine (Phila Pa 1976)*. 2011 Jul 1;36(15):E1046-51. doi: 10.1097/BRS.0b013e3181fe78c. PMID: 21289552.
33. Abeloos L, De Witte O, Walsdorff M, Delpierre I, Bruneau M. Posterior osteosynthesis of the atlas for nonconsolidated Jefferson fractures: a new surgical technique. *Spine (Phila Pa 1976)*. 2011 Sep 15;36(20):E1360-3. doi: 10.1097/BRS.0b013e318206cf63. PMID: 21358480.
34. Kwon HC, Cho DK, Jang YY, Lee SJ, Hyun JK, Kim TU. Collet-sicard syndrome in a patient with jefferson fracture. *Ann Rehabil Med*. 2011 Dec;35(6):934-8. doi: 10.5535/arm.2011.35.6.934. Epub 2011 Dec 30. PMID: 22506224; PMCID: PMC3309376.
35. Kong SJ, Park JH, Roh SW. Occipital neuralgia after occipital cervical fusion to treat an unstable jefferson fracture. *Korean J Spine*. 2012 Dec;9(4):358-61. doi: 10.14245/kjs.2012.9.4.358. Epub 2012 Dec 31. PMID: 25983846; PMCID: PMC4430563.
36. Ganau M, Spinelli R, Tacconi L. Complex developmental abnormality of the atlas mimicking a Jefferson fracture: Diagnostic tips and tricks. *J Emerg Trauma Shock*. 2013 Jan;6(1):47-9. doi: 10.4103/0974-2700.106325. PMID: 23493176; PMCID: PMC3589859.
37. Dettling SD, Morscher MA, Masin JS, Adamczyk MJ. Cranial nerve IX and X impairment after a sports-related Jefferson (C1) fracture in a 16-year-old male: a case report. *J Pediatr Orthop*. 2013 Apr-May;33(3):e23-7. doi: 10.1097/BPO.0b013e3182746bc1. PMID: 23482276.
38. Hu Y, Albert TJ, Kepler CK, Ma WH, Yuan ZS, Dong WX. Unstable Jefferson fractures: Results of transoral osteosynthesis. *Indian J Orthop*. 2014 Mar;48(2):145-51. doi: 10.4103/0019-5413.128750. PMID: 24741135; PMCID: PMC3977369.

39. Hu Y, Xu RM, Albert TJ, Vaccaro AR, Zhao HY, Ma WH, Gu YJ, Yuan ZS. Function-preserving reduction and fixation of unstable Jefferson fractures using a C1 posterior limited construct. *J Spinal Disord Tech.* 2014 Aug;27(6):E219-25. doi: 10.1097/BSD.0b013e31829a36c5. PMID: 24463337.
40. Allam E, Zhou Y. Bipartite Atlas or Jefferson Fracture? A Case Series and Literature Review. *Spine (Phila Pa 1976).* 2015 Jun 1;40(11):E661-4. doi: 10.1097/BRS.0000000000000874. PMID: 26091159.
41. Pawar AY, O'Leary PF. Combined Type II Odontoid Fracture with Jefferson's Fracture Treated with Temporary Internal Fixation. *Asian Spine J.* 2015 Dec;9(6):966-70.
42. Bevevino AJ, Tee J, Ailon T, Dvorak M. Are Jefferson Fractures With a Transverse Ligament Avulsion Potentially Unstable? *Clin Spine Surg.* 2016 Mar;29(2):39-41. doi: 10.1097/BSD.0000000000000362. PMID: 26841207.
43. Arias-Berrios RE, Grigg Ortiz SA, Betances Ramirez NM, Ortiz Santiago AM, Báez JA. Poster 443 Diving Injury Resulting in a Jefferson Fracture, Vertebral Artery Thrombosis and Brown Sequard Syndrome: A Case Report. *PM R.* 2016 Sep;8(9S):S305. doi: 10.1016/j.pmrj.2016.07.367. Epub 2016 Sep 24. PMID: 27673193.
44. Hu Y, Yuan ZS, Kepler CK, Dong WX, Sun XY, Zhang J. Comparison of occipitocervical and atlantoaxial fusion in treatment of unstable Jefferson fractures. *Indian J Orthop.* 2017 Jan-Feb;51(1):28-35. doi: 10.4103/0019-5413.197517. PMID: 28216748; PMCID: PMC5296845.
45. Ottenbacher A, Bettag M. Resolution of traumatic vertebral artery dissection and occlusion after repositioning and posterior C1-ring osteosynthesis of a displaced Jefferson burst fracture. *Acta Neurochir (Wien).* 2017 Aug;159(8):1561-1564. doi: 10.1007/s00701-017-3241-x. Epub 2017 Jun 29. PMID: 28660396.
46. Woods RO, Inceoglu S, Akpolat YT, Cheng WK, Jabo B, Danisa O. C1 Lateral Mass Displacement and Transverse Atlantal Ligament Failure in Jefferson's Fracture: A Biomechanical Study of the "Rule of Spence". *Neurosurgery.* 2018 Feb 1;82(2):226-231. doi: 10.1093/neuros/nyx194. PMID: 28431136.
47. Rodts GE, Baum GR, Stewart FG, Heller JG. Motion-preserving, 2-stage transoral and posterior treatment of an unstable Jefferson fracture in a professional football player. *J Neurosurg Spine.* 2018 Feb;28(2):149-153. doi: 10.3171/2017.6.SPINE17274. Epub 2017 Dec 1. PMID: 29192878.
48. Baek SH, Yoo SH, Cho KR, Shin JJ. Cerebellar infarction after posterior direct reduction and fixation to treat an unstable Jefferson fracture: a case report. *Acta Neurochir (Wien).* 2018 Mar;160(3):471-477. doi: 10.1007/s00701-017-3443-2. Epub 2018 Jan 6. PMID: 29307021.
49. Tay SY, Li CW, Ko CH, Chan WP. A Nonsurgical Solution: Jefferson (Burst) Fracture. *Am J Med.* 2018 Sep;131(9):1061-1063. doi: 10.1016/j.amjmed.2018.05.018. Epub 2018 Jun 11. PMID: 29902422.