THE ROLE OF CERVICAL PEDICLE SCREW (CPS) IN CERVICAL SPINE TRAUMA: AN UPDATE AND REVIEW.

Igor Ebert Cechin[1]

Alderico Girão Campos de Barros[1]

Ahsan Ali Khan[1]

Luis Eduardo Carelli Teixeira da Silva[1]

[1] ARCOL – Área de Cirurgia da Coluna, Instituto Nacional de Ortopedia e Traumatologia Jammil Haddad – INTO-MS; Rio de Janeiro, Brasil.

KEYWORDS: *Cervical pedicle screw; Subaxial fractures; Cervical spine trauma.*

INTRODUCTION: Placement of pedicle screw in the subaxial cervical spine is a challenging and complex technique but provides significant biomechanical advantages. Despite its potential complications, the role and use of cervical pedicle screw (CPS) is growing.

MATERIALS AND METHODS: Literature review of the significant articles regarding the application of pedicle screws in the subaxial cervical spine was done (articles between 1994 and 2020). Furthermore, our center´s experience of 15 years related with CPS is also discussed in this study.

RESULTS: Transpedicular instrumentation in the subaxial cervical spine requires profound anatomical knowledge and thorough surgical technique. This technique provides superior biomechanical stability as compared to the other cervical fixation techniques. Pull-out strength of CPS is twice as compared to the lateral mass screws. There have been numerous variations in the technique of CPS varying from open techniques, minimal invasive and use of biomodels and templates during this procedure. Clinically, CPS can be used in different cervical trauma situations, such as fracture-dislocations, floating lateral mass and fractures associated with ankylosing spondylitis. Despite the possibility of neurovascular injury due to the proximity of vertebral artery, spinal cord and spinal nerves to the cervical pedicles, scientific literature and our center´s experience show low risk, and this technique can be performed safely.

CONCLUSION: Cervical pedicle screw placement is a safe procedure, and it has great potential in the management of cervical spine trauma.

REFERENCES

1-Kwon BR, Vaccaro AR, Grauer JN, Fisher CG, Dvorak MF. Subaxial Cervical Spine Trauma. J Am Acad Orthop Surg 2006; 14: 78-89.

2-Feuchtbaum E, Buchowski J, Zebala L. Subaxial cervical spine trauma. Curr Rev Musculoskeletal Med (2016) 9:496-504. DOI 10.1007/s12178-016-9377-0

3- Abumi K, Itoh H, Taneichi H, Kaneda K. Transpedicular screw fixation for traumatic lesions of the middle and lower cervical spine: description of the techniques and preliminary report. Journal of Spinal Disorders 1994. Vol 7. No 1, pp 19-28.

4-Joaquim AF, Mudo ML, Tan LA, Riew KD. Posterior Subaxial Cervical Spine Screw Fixation: A Review of Techniques Global Spine Journal 2018; Vol 8(7) 751-760. DOI 10.1172/2192568218759940

5-Schmidt R, Wilke HJ, Claes L, Puhl W, Richter M. Pedicle screws enhance primary stability in multilevel cervical corpectomies: biomechanical *in vitro* comparison of different implants including constrained and non-constrained posterior instrumentations. Spine 2003, Number 16, pp 1821-1828.

6-Jones EL, Heller JG, Silcox H, Hutton WC. Cervical pedicle screws *versus* Lateral mass screws. Spine 1997, Volume 22, Number 9, pp 977-982.

7- White AA, Johnson RM, Panjabi MM, Southwick WO. Biomechanical analysis of clinical stability in the cervical spine. Clinical Orthopaedics and Related Research 1975, Number 109, pp 85-96.

8-Ludwig S, Kramer DL, Vaccaro AR, Albert TJ. Transpedicle screw fixation of the cervical spine. Clin Orthop and Related Research 1999. Number 359, pp 77-88.

9-Kotani Y, Cunningham BW, Abumi K, McAfee PC. Biomechanical analysis of cervical stabilization systems. Spine 1994. Vol 19, Number 22, pp 2529 – 2539.

10-Kowalski JM, Ludwig SC, Hutton WC, Heller JG. Cervical spine pedicle screws. Spine 2000. Vol 25, Number 22, pp 2865-2867

11-Kothe R, Ruther W, Schneider E, Linke B. Biomechanical analysis of transpedicular screw fixation in the subaxial cervical spine. Spine 2004, Vol 29, Number 17, pp 1869-1875.

12-Johnston TL, Karaikovic EE, Lautenschlager EP, Marcu D. Cervical pedicle screw vs. Lateral mass screws: uniplanar fatigue analysis and residual pullout strengths. The Spine Journal 6 (2006) 667-672. DOI 10.1016/j.spinee.2006.03.19.

13-Jung YG, Lee S, Jeong SK, Kim M, Park JH. Subaxial cervical pedicle screw in traumatic spinal surgery. Korean J Neurotrauma. 2020 Apr; 16(1): 18-27. DOI 10.13004/kjnt.2020.16.e13

14-Manoso MW, Moore TA, Agel J, Bellabarba C, Bransford RJ. Floating lateral mass fractures of the cervical spine. Spine 2016, Volume 41, Number 18, pp 1421-1427.

15-Jeanneret B, Gebhard JS, Magerl F. Transpedicular screw fixation of articular mass fracture-separation: results of an anatomical study and operative technique. Journal of Spinal Disorders 1994. Vol 7, Number 3, pp 222-229.

16-Park JH, Roh SW, Rhim SC. A single-stage posterior approach with open reduction and pedicle screw fixation in subaxial cervical facet dislocations. J Neurosurg Spine, April 24, 2015. DOI 10.3171/2014.11.SPINE14805

17-Tofuko K, Koga H, Yone K, Komiya S. Distractive flexion injuries of the subaxial cervical spine trated with a posterior procedure using cervical pedicle screws or a combined anterior and posterior procedure. Journal of Clinical Neuroscience 20 (2013) 697-701.

18-Abumi K, Ito M, Sudo H. Reconstruction of the subaxial cervical spine using pedicle screw instrumentation. Spine 2012, Volume 37, Number 5, pp E349-E356.

19-Li L, Li C, Duan J, Zhang L, Liu Z. Surgical treatment for old subaxial cervical dislocation with bilateral locked facets in a 3-year-old girl. Medicine (2018) 97:18(e0553). DOI: 10.1097/MD.0000000000010553.

20- Rajasekaran S, Kana PRM, Shetty AP. Safety of cervical pedicle screw insertion in children. Spine 2012, Volume 37, Number 4, pp E216-E223.

21-Duff J, Hussain MM, Klocke N, Harris JA, Yandamuri SS, Bobinski L, Daniel RT, Bucklen BS. Does pedicle screw fixation of the subaxial cervical spine provide adequate stabilization in a multilevel vertebral body fracture model? An in vitro biomechanical study. Clinical Biomechanics 53 (2018) 72-78.

22- Hostin RA, Wu C, Perra JH, Polly DW, Akesen B, Wroblewski JM. A biomechanical evaluation of three revision screw strategies for failed lateral mass fixation. Spine 2008, Volume 33, Number 22, pp 2415-2422.

23-Cornefjord M, Alemany M, Olerud C. Posterior fixation of subaxial cervical spine fractures in patients with ankylosing spondylitis. Eur Spine J (2005) 14:401-408. DOI 10.1007/s00586-004-0733-1

24-Chon H, Park JH. Cervical vertebral body fracture with ankylosing spondylitis treated with cervical pedicle screw: A fracture body overlapping reduction technique. Journal of Clinical Neuroscience, 2017. DOI 10.1016/j.jocn.2017.04.012

25- Yan L, Luo Z, He B, Liu J, Hao D. Posterior pedicle screw fixation to treat lower cervical fractures associated with ankylosing spondylitis: a retrospective study of 35 cases. BMC Musculoskeletal Disorders (2017) 18:81. DOI 10.1186/s12891-017-1396-5

26- Koller H, Robinson Y. Cervical Spine Surgery: Standard and Advanced Techniques. 2019. Cap 68, pp 449-454.

27- Tukkapuram VR, Abumi K, Ito M. A review of the historical evolution, biomechanical advantage, clinical applications, and safe insertion techniques of cervical pedicle screw fixation. Spine Surg Relat Res 2019; 3(2): 126-135

28- Yukawa Y, Kato F, Yoshihara H, Yanase M, Ito K. Cervical pedicle screw fixation in 100 cases of unstable cervical injuries: pedicle axis view obtained using fluoroscopy. J Neurosurg Spine 5: 488-493, 2006.

29- Karaikovic E, Yingsakmongkol W, Gaines Jr RW. Accuracy of cervical pedicle screw placement using the funnel technique. Spine 2001, Vol 26, Number 22, pp 2456-2462.

30- Lee JH, Choi BK, Han IH, Choi WG, Nam KH, Kim HS. Cervical pedicle screw placement using medial funnel technique. Korean J Spine 14(3): 84-88, 2017.

31- Schaefer C, Begemann P, Fuhrhop I, Schroeder M, Viezens L, Wiesner L, Hansen-Algenstaedt N. Percutaneous instrumentation of the cervical and cervico-thoracic spine using pedicle screws: preliminary clinical results and analysis of accuracy. Eur Spine J (2011) 20:977-985. DOI 10.1007/s00586-011-1775-9.

32- Lee SH, Kim KT, Abumi K, Suk KS, Lee JH, Park KJ. Cervical pedicle screw placement using the "Key Slot Technique". The feasibility and learnig curve. J Spinal Disord Tech 2012; 25-415-421.

33-Park JH, Jeon SR, Roh SW, Kim JH, Rim SC. The safety and accuracy of freehand pedicle screw placement in the subaxial cervical spine. Spine 2014, Volume 39, Number 4, pp 280-285.

34- Jung YG, Jung SK, Lee BJ, Lee S, Jeong SK, Kim M, Park JH. The subaxial cervical pedicle screw for cervical spine diseases: the review of technical developments and complication avoidance. Neurol Med Chir (Tokyo) 60, 231-243, 2020.

35 – Silva LECT, Cuellar DJ, Barros AGC, Khan AA. Three-dimensional biomodel use in the surgical management of basilar invagination with congenital cervical scoliosis; correction by unilateral C1-C2 facet distraction. Journal of Craniovertebral Junction and Spine, 11(4), 347, 2020.

36- Kast E, Mohr K, Richter HP, Borm W. Complications of transpedicular screw fixation in the cervical spine. Eur Spine J (2006) 15: 327-334.

37- Uehara M, Takahashi J, Ikegami S, Mukaiyama K, Kuraishi S, Shimizu M, Futatsugi T, Ogihara N, Hashidate H, Hirabayashi H, Kato H. Screw perforation features in 129 consecutive patients performed computer-guided cervical pedicle screw insertion. Eur Spine J (2014) 23:2189-2195

38 – Neo M, Sakamoto T, Fujibayashi S, Nakamura T. The clinical risk of vertebral artery injury from cervical pedicle screws inserterd in degenerative vertebrae. SPINE 2005, volume 30, number 24, pp 2800 - 2805

39- Abumi K, Shono Y, Ito M, Taneichi H, Kotani Y, Kaneda K. Complications of pedicle screw fixation in reconstructive surgery of the cervical spine. Spine 2000, Volume 25, Number 8, pp 962-969.