The role of 3D-printing technology in the diagnosis of Eagle syndrome
A case report
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Abstract
Rationale: Eagle syndrome is a rare clinical condition that can be associated with elongation of the styloid process.
Patient concern: A 55-year-old man was presented with vague throat discomfort for several years.
Diagnosis: 3-dimensional (3D) computed tomography (CT) reconstruction, and printing revealed bilateral elongated styloid processes.
Interventions: The patient has been treated medically, and continues to demonstrate improvement with conservative treatment for 2 years.
Outcome: We report usefulness of 3D CT and 3D printing technology for diagnosis of Eagle syndrome.
Lessons: 3D CT reconstruction, and printing are beneficial in determining appropriate surgical strategy, and allowing the physician to better explain the lesion, and surgical details to patients.
Abbreviations: 3D = 3-dimensional, CT = computed tomography.

Keywords: computed tomography, eagle syndrome, three-dimensional printing

1. Introduction
Eagle syndrome is a rare clinical condition that can be associated with elongation of the styloid process.[1–4] The lengths of styloid process greater than 3 cm are elongated.[1,4] Multi-slice computed tomography (CT) and 3-dimensional (3D) reconstruction is the best diagnosis method in radiological diagnosis.[1,2] Herein, we report usefulness of 3D CT and 3D printing technology for diagnosis of Eagle syndrome.

2. Case report
A 55-year-old man was presented with vague throat discomfort for several years. The patient did not complain about radiating pain, exacerbating, or relieving movements, or positions. Medical history was uneventful for significant trauma, or surgery. On physical examination, bilateral whitish bony prominences were observed on inferior portion of the tonsil (Fig. 1). Solid masses were detected on intraoral palpation of both tonsil fossa. The patient underwent panoramic radiograph, and 3D CT scan (Fig. 2). The skull model was fabricated using 3D printing technology (Medical IP Co., Ltd. Seoul, South Korea; Fig. 3). 3D CT reconstruction, and printing revealed bilateral elongated styloid processes with their lower tips at the lower C2 level of the vertebral body with approximately, 5.5 cm on the right side, and 5.7 cm on the left side, respectively. Based on these observations, the patient was diagnosed with Eagle syndrome. The patient had been treated with conservative treatment, including reassurance...
to the patient, and non-steroidal anti-inflammatory medications for several months. Since then, the patient has been well without any symptoms, or medication. This study was approved by the institutional review board of the Chonnam National University Hwasun Hospital. Informed consent was given by the patient.

3. Discussion

There are 3 criteria for diagnosis of Eagle syndrome; first, a dull, and persistent pain in oropharynx, and face, second, a palpable elongated styloid process in the tonsillar fossa, third, detection of elongated styloid process by radiologic examinations.\(^ {1-4}\) There are several theories of the cause of Eagle syndrome, including idiopathic, congenital, or acquired.\(^ {2,3}\) However, pathogenesis of Eagle syndrome is not well established.

The typical symptom of Eagle syndrome is oral pain localized in the tonsillar fossa, and sometimes accompanied by dysphagia, foreign body sensation, voice change, and tinnitus.\(^ {1-3}\) However, it is difficult to distinguish other oral, and maxillofacial pathology because these symptoms are similar, and nonspecific.\(^ {1}\)

Diagnosis of Eagle syndrome is usually made by physical examination by digital palpation of elongated styloid process, and radiologic examinations.\(^ {1-4}\) Multi-slice CT, and 3D reconstruction is the best diagnosis method for Eagle syndrome.\(^ {1-2}\) 3D CT reconstruction, and printing are beneficial for determining appropriate surgical strategy, and allowing the physician to better explain the lesion, and surgical details to patients.\(^ {1-3}\)

Treatment of Eagle syndrome includes conservative treatment, and surgery.\(^ {1-4}\) Treatment method depends on the patient’s symptoms. Conservative treatment includes reassurance, analgesics medication, and steroid injection.\(^ {1-3}\) Surgical treatment can be conducted shortening of the elongated styloid process through intraoral, or external approach.\(^ {1-4}\) In this case, we successfully, treated the patient with conservative treatment.

In conclusion, Eagle syndrome is a rare clinical condition that can be associated with elongation of the styloid process. We report usefulness of 3D CT, and 3D printing technology for diagnosis of Eagle syndrome. 3D CT reconstruction, and printing are beneficial in determining appropriate surgical strategy, and allowing the physician to better explain the lesion, and surgical details to patients.

4. Summary

Eagle syndrome is a rare clinical condition that can be associated with elongation of the styloid process. 3D CT reconstruction and printing are beneficial in determining appropriate surgical strategy, and allowing the physician to better explain the lesion, and surgical details to patients.

Author contributions

Data curation: D.H. Lee, T.M. Yoon.
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References

[1] Ferreira PC, Mendanha M, Frada T, et al. Eagle syndrome. J Craniofac Surg 2014;25:e84–6.
[2] Kamal A, Nazir R, Usman M, et al. Eagle syndrome; radiological evaluation and management. J Pak Med Assoc 2014;64:1315–7.
[3] Raina D, Gothi R, Rajan S. Eagle syndrome. Indian J Radiol Imaging 2009;19:107–8.
[4] Elmas F, Shrestha BL. Eagle’s syndrome. N Engl J Med 2017;377:e18.