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Case Study

3D Printer Assisted C1-C2 Posterior Spinal Fusion

3B Yazıcı Destekli C1-C2 Posterior Spinal Füzyon

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Abstract: Odontoid fractures often occur after trauma. The vascular and neural structures that are close in the cases planned for surgery increase the complications of the operation. With the recent technological advances, anatomic simulations with 3D printers have enabled the operation to be performed in less time with less risk in order to perform safer surgery. We performed a posterior C1-C2 fusion procedure in a 62-year-old patient who developed odontoid fracture after trauma with the help of anatomical simulation we wrote with a 3D printer and we wanted to present this case.
Keywords: Odontoid fractures, C1-C2 posterior fusion, 3D printer.

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Özet: Odontoid kırıklar sıklıkla travma sonrası ortaya çıkmaktadır. Cerrahi planlanan vakalarda yakın bulunan vaskuler ve nöral yapılar operasyonun komplikasyonlarını arttırmaktadır. Son dönemde artan teknolojik gelişmeler ile birlikte daha güvenli cerrahi yapılabilmesi için 3 boyutlu yazıcılar ile anatomik simülasyonlar operasyonun daha az riskle daha kısa zamanda yapılabilmesi imkanını sağlamıştır. Biz 62 yaşında travma sonrası odontoid kırığı gelişen bir hastamızda posterior C1-C2 fuzyon işlemini 3boyutlu yazıcı ile yazdığımız anatomik simülasyon yardımı ile yaptık ve bu vakamızı sunmak istedik.
Anahtar Kelimeler: Odontoid kırığı, C1-2 posterior füzyon, 3 Boyutlu yazıcı

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1. Introduction

Atlantoaxial instability may develop in the craniocervical junction as a result of trauma, congenital deformity, tumor, infection or rheumatologic degeneration. It should be treated because it causes serious complications such as neurological dysfunction, respiratory distress, or even sudden death [1]. Odontoid fractures have been reported to account for 15% of all cervical traumas [2]. Although treatment of odontoid fractures varies from case to case, follow-up with an appropriate orthosis is performed as anterior odontoid screwing and posterior C1-2 fusion [2]. Surgical intervention has become more dominant in treatment by decreasing surgical mortality and morbidity due to recent technological advances. Anterior odontoid screwing or short-term posterior c1-2 fusion is recommended in young patients because c1-2 fusion restricts neck movements. C1-2 posterior stabilization has been shown to have a higher rate of fusion [2].

During posterior stabilization of the craniocervical region C1-2 vertebrae (C1 lateral mass during the Harms / Goel technique, C2 pedicular screwing), due to anatomical structure of the region, arterial and nerve injuries during screwing, or due to differences in lateral mass and pedicular structure of both corpus, sufficient amount of bone tissue failure of the system and insufficient fusion [3]. In order to simplify such a risky operation, preoperative anatomical simulations with 3D printers result in less risky, safer and faster operations.

We performed anterior odontoid screwing because of the odontoid fracture. however, we thought that fusion could not be sufficient in our patient and we operated on the patient with 3D printer-assisted anatomic simulation with posterior C1-2 (Harms / Goel) technique in another session and we wanted to share this experience.

2. Case

A 62-year-old female patient complained of pain in the neck movements that started after a minor trauma for 3 months. The patient had no neurological deficit but complained of neck pain in the last weeks with head extension. The patient underwent a percutaneous anterior odontoid screwing operation (Fig. 1) because the type 2B odontoid fracture (Anderson and D’Alonzo [2]) was detected in the imaging. The operation was completed with a 4.0mm lack screw. Computed tomography performed postoperatively revealed that the intracorporal part of the screw was insufficient at the C2 level (fig. 2). Two days later, C1-2 posterior stabilization (Harms / Goel [2]) was performed with the aid of anatomical simulation written with a 3D printer (fig. 3,4). The patient was discharged on the second day without any postoperative neurological deficit.

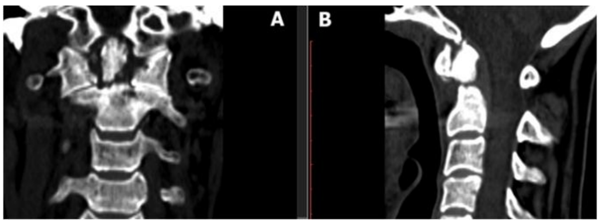

Figure1.
A, B: preoperative coronal and sagittal computed tomography slices type 2B odontoid fracture.

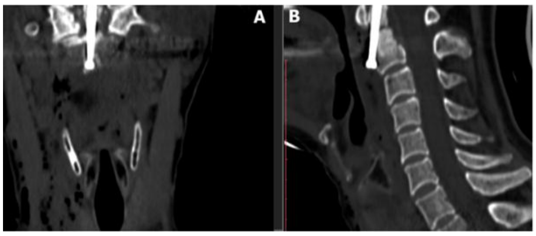

Figure2.
A, B: postoperative coronal and sagittal computed tomography slices intracorporal part of the screw was insufficient at the C2 level.

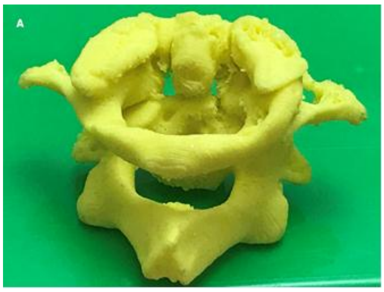

Figure 3.
A: Anatomical simulation was written by the 3D printer.

Figure 4.
A: Postoperative X-ray C1-2 posterior spine fusion

3. Discussion

The incidence of odontoid fractures increases with age and is the most common cervical fracture in patients over 70 years of age [4]. Low-energy traumas constitute a source in the elderly and high-energy traumas in the young and middle-aged population [5]. Type II fractures are the most common odontoid fractures and occur in 65-74% of cases.

While treatment strategies for odontoid fractures have been conservative treatment and immobilization (such as cervical arms, Minerva, other cervicochoric orthoses and halo orthoses) in the previous periods, atlantoaxial fusion has become one of the main methods in the treatment of atlantoaxial instability with technological advances in spinal surgery and the emergence of new fusion techniques. [4].

According to the American Association of Neurological Surgeons, anterior or posterior atlantoaxial fusion is an acceptable surgical option in the treatment of type 2 odontoid fractures [4]. Complications such as dysphagia, pneumonia, vocal cord paralysis, and gastrostomy tube placement have been reported in the literature following anterior odontoid stabilization surgery, which is frequently performed in elderly patients [4, 6]. However, anterior odontoid stabilization is one of the options that can be selected with an early fracture (<6 months), with a fusion rate of up to 80-100% in young patients [4]. Posterior atlantoaxial stabilization can be performed in cases where anterior surgery is contraindicated (transverse ligament damage, anterior-inferior, posterior-superior located dens, irreducible fractures, cases without fusion, severe cervicothoracic kyphosis and osteoporosis [4, 7, 8]). Finally, as in our case, anterior surgery is performed as a rescue operation in case of failure [4]. While posterior stabilization provides a fusion rate of up to 100%, it can cause more serious complications (vertebral artery injury, spinal cord injury, bleeding, infection) during the operation [3]. Therefore, with the introduction of 3D printers into the surgical field, posterior stabilization, which requires serious surgical experience, can be performed more easily and in a shorter time.

In upper cervical spine surgery, personalized 3D printer assisted simulations and pedicle screw fixation are low cost and do not require special equipment (perioperative CT, navigation). It is enough for the surgical team to know the 3D printer software adequately in terms of surgical planning.

To ensure safe screw placement in cases where no 3D printer is used, the amount of bleeding increases and more exposure to the X-ray occurs for both the patient and the operating team. Moving the scopy device frequently and re-entering the operating room may increase the likelihood of surgical infection [9, 10]. Zheng et al. In his study, venous plexus injury in 6 (7%) patients, C2 root injury in 4 (4.7%) patients, urinary tract infection in one patient and wound infection in one patient [1]. Jing et al. The rate of complications was 6.67% (2 patients). One patient had intra-vertebral artery damage while screwing the C1 lateral mass, and one patient had screw loosening during follow-up [11]. In a study conducted by Gao et al, it was reported that the operation could be completed more safely by reducing perioperative errors in posterior stabilization for craniovertebral junction anomalies guided by 3D printer [12].

4. Conclusion

The use of 3D printer technology in the upper cervical stabilization process, which may cause high vital risks in spinal surgery, reduces surgical risks and complications. It seems inevitable that he will undergo a routine surgical planning procedure in the following years.

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