

3d-Printer Assisted Transsphenoidal Hypophysectomy Üç Boyutlu Yazıcı Yardımı ile Transfenoidal Hipofizektomi

¹Ali Osman Mucuoglu, ¹Muharrem Furkan Yuzbası, ¹Ege Coskun,
²Bugra Husemoglu, ¹Ercan Ozer

¹Dokuz Eylul University School of Medicine, Department of Neurosurgery, Izmir, Turkey

²Dokuz Eylül University Health Science Institute, Department of Biomechanics, Izmir, Turkey

Abstract: Acromegaly is a chronic disease usually a result of a pituitary adenoma. Transsphenoidal surgery is the most commonly used technique for the surgical treatment of pituitary adenoma. The use of 3D printed sphenoid bone for presurgical plan decrease the risk of complication. We present a classic case of transsphenoidal hypophysectomy. This was case of 47 year old male acromegaly disease. He has a cystic pituitary macroadenoma on the left side of the gland. We used 3D printed sphenoid bone for presurgical planning. There was no complication per or postoperatively. Postoperative magnetic resonance imaging done and hormone level was successfully decreased. Surgical resection of pituitary adenoma with transnasal route asissted with preoperative 3D modelling appears to be a effective method in the future.

Keywords: Transsphenoidal hypophysectomy, acromegaly, 3D printing, sphenoid bone

Mucuoglu AO, Yuzbasi MF, Coskun E, Husemoglu RB, Ozer E, 2019. 3d-Printer Assisted Transsphenoidal Hypophysectomy, *Journal of Medical Innovation and Technology*

Özet: Akromegali, genellikle hipofiz adenomu sonucu oluşan kronik bir hastalıktır. Transsfenoidal cerrahi, hipofiz adenomlarının cerrahi tedavisinde en sık kullanılan tekniktir. Cerrahi plan için 3D yazıcıyla basılmış sfenoid kemik kullanılması komplikasyon riskini azaltır. Bu sunumda klasik bir transsfenoidal hipofizektomi olgusunu sunuyoruz. Bu olgu, 47 yaşında, erkek akromegali hastasıydı. Bezin sol yanında kistik bir hipofiz makroadenomuna sahipti. Transsfenoidal yolun cerrahi öncesi planı için 3D yazıcıyla basılmış sfenoid kemik kullandık. Peroperatif ve postoperatif dönemde herhangi bir komplikasyon olmadı. Postoperatif kontrol MRG ve hormon seviyeleri tedavi için başarılıydı. Gelecekte preoperatif 3D modelleme yardımı ile yapılan transnazal transsfenoidal hipofizektomi etkin bir yöntem gibi görünmektedir.

Anahtar Kelimeler: Transsfenoidal hipofizektomi, akromegali, 3B baskı, sfenoid kemik

Mucuoglu AO, Yuzbası MF, Coşkun E, Hüsemoğlu RB, Özer E, 2019. Üç Boyutlu Yazıcı Yardımı ile Transfenoidal Hipofizektomi, *Medikal İnovasyon ve Teknoloji Dergisi*

ORCID ID of the authors: A.O.M 0000-0003-1748-6337, M.F.Y 0000-0002-2816-6921, E.C 0000-0002-5582-9786, R.B.H 0000-0003-1979-160X. E.Ö 0000-0001-9011-5706

1. Introduction

Acromegaly is a chronic disease characterized by excessive release of growth hormone (GH) and increased levels of insulin-like growth factor (IGF-1) usually a result of a pituitary adenoma. Mostly, demonstrated by dysmorphic craniofacial and extremity changes accompanied by cardiovascular, metabolic or respiratory complications.(1)

3D printer is a high-tech device transforming a 3D-model created in computer environment into a real physical object. In the recent practice, the standard surgical option for these adenomas is the transnasal transsphenoidal route. The deep surgical corridor and presence of osseous variations are the major challenges for the surgeon and increase the complication rates. 3D printing is used for preoperative evaluation as well as developmental process of medical devices and prosthesis. 3D models specific for each patient provide the surgeon to plan and perform preoperatively thus reduce the peroperative complications. In this case, our 3D printed the surgical anatomy of sphenoid bone in order to decrease the surgical duration and the risk of complications and surgical planning was done preoperatively.(2)

2. Case

47- year old male referred with the feeling of enlargement on fascial bones, impotence and

weakness for about last 6 months. The IGF-1 and GH serum levels were 619 $\mu\text{g}/\text{dl}$ and 16,3 $\mu\text{g}/\text{dl}$ respectively with the pre-diagnosis of acromegaly. 9x10 mm cystic hypophysis macroadenoma on the left side of the gland was shown on magnetic resonance imaging (MRI). Operation was recommended and preoperative imaging was obtained via 1mm-sliced computed tomography (CT). The data was stored in DICOM (Digital Imaging and Communications in Medicine) format. Segmentation process was performed on the DICOM data with Mimics software (Materialize, Leuven, Belgium) then surface improvements were done. A thermoplastic material called PLA (polylactic acid) filaments was selected for printing. The production of the models is done with a 3D-printer supporting 'Fused Deposition Modelling'(Figure 1). Transnasal transsphenoidal surgery was done after the preoperative planning on the 3D-printed model. There was no complication per or postoperatively. We observed that we used planned transsphenoidal route in postoperative control CT and we provided effective surgical resection in postoperative control MRI (Figure 2). Postoperative control IGF-1 and GH serum levels were 257 $\mu\text{g}/\text{dl}$ and 1,36 $\mu\text{g}/\text{dl}$ respectively. The patient was discharged on postoperative fourth day.

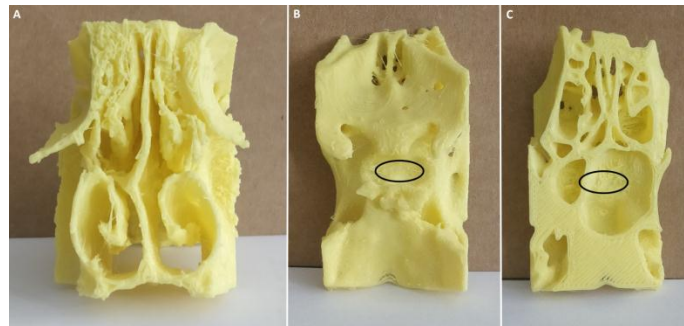


Figure 1. (A); preoperative transsphenoidal route, (B); showing posterior view of sella tursica (black circle showing craniectomy area), (C); showing anterior view of sella tursica with sphenoid sinus (black circle showing craniectomy area)

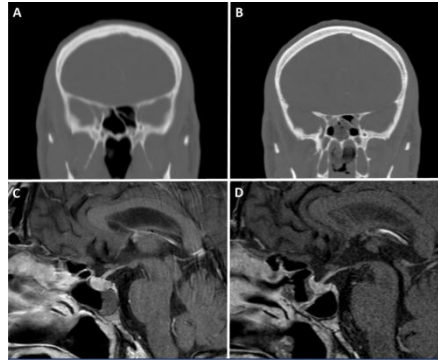


Figure 2. (A); preoperative cranial CT, coronal section, (B); postoperative cranial CT coronal section, (C); preoperative T1 post-contrast pituitary MRI, sagittal section, (D); postoperative T1 post-contrast pituitary MRI, sagittal section

3. Discussion

The treatment of choice in acromegaly is surgery. The accepted method is the total excision of the lesion. Whereby preventing the recurrence and potential morbidity and mortality due to the unregulated release of GH/IGF-1 are aimed.(1, 3) In our case, the patient is referred to us urgently after the diagnosis by endocrinologists.

The use of the preoperative 3D modelling is increased in recent years to avoid the complications. In patients with acromegaly, the risk of injury to the carotid artery is increased due to the anatomical variations like decreased intercarotid distance. The risk of injury to the carotid artery is decreased with the use of intraoperative navigation. However due to the concerns about the cost, the widespread use remained limited. In our clinic, we use 3D modelling routinely in patients performed cranioplasty and C1-C2 fusion. We applied this technique to the patients with pituitary adenoma treated with transsphenoidal surgery. The reason for GH hypersecretion is a pituitary adenoma called somatotropinoma among 90% of acromegaly cases.(4) In our case, the pathology showed focal positivity for ACTH and prolactin.

The rise in serum GH levels is not specific for acromegaly. It might be related with congenital or acquired causes. After the rise in serum IGF-1 level and pituitary adenoma on cranial MRI are shown combined with the clinical findings, the diagnosis of acromegaly can be done.(5, 6) In our case, first serum levels of GH and IGF-1 were determined. When the increased levels were demonstrated, hypophysis MRI was

performed and the macroadenoma was diagnosed.

In year 2010, the recent consensus remission criteria was published. Accordingly, random GH serum level should be < 1ng/ml, and serum IGF-1 level should be normal for the age and gender.(7) In our case, postoperative serum IGF-1 level was 257 µg/dl (normal value 53,3-215 µg/dl), serum GH level was 1,36 µg/dl and considered as close to the remission criteria.

Transsphenoidal route is the most commonly used technique for the surgical treatment of pituitary adenomas. This can be used with ease except for suprasellar extradurally or lateral wall of cavernous sinus locations.(8) In our case, transnasal transsphenoidal approach used with microscope. The location of the tumor was influential for the decision. Given the close vascular structure this route is considered to be a hard one. Therefore in our case, 3D-model of the sphenoid bone printed by 3D printer was obtained. The localization of the tumor and the passage route was visualized. The surgery was done without any complications. In the literature, we could not identify a similar case.

4. Conclusion

The treatment of choice in patients diagnosed with acromegaly is surgery and the preferred technique is transnasal transsphenoidal approach. Surgical resection assisted with preoperative 3D-modelling appears to be an effective method. Use of these models help the surgeons to simulate the surgery itself preoperatively. 3D modelling decreases preoperative complications, shortens the

duration of surgery thus increases intraoperative safety. In the future, given that provides cheap and personalized modelling 3D

printing will become widely used not only in neurosurgery but also in the other fields.

REFERENCES

1. Melmed S, Colao A, Barkan A, Molitch M, Grossman A, Kleinberg D, et al. Guidelines for acromegaly management: an update. *The Journal of Clinical Endocrinology & Metabolism*. 2009;94(5):1509-17.
2. Vakharia VN, Vakharia NN, Hill CS. Review of 3-dimensional printing on cranial neurosurgery simulation training. *World neurosurgery*. 2016;88:188-98.
3. Krzentowska-Korek A, Gołkowski F, Bałdys-Waligórska A, Hubalewska-Dydejczyk A. Efficacy and complications of neurosurgical treatment of acromegaly. *Pituitary*. 2011;14(2):157-62.
4. Grottoli S, Gasco V, Ragazzoni F, Ghigo E. Hormonal diagnosis of GH hypersecretory states. *Journal of endocrinological investigation*. 2003;26(10 Suppl):27-35.
5. GRUBU THÇ. Hipofiz Hastalıkları Tani, Tedavi ve izlem Kilavuzu. Ankara, Türkiye Endokrinoloji ve Metabolizma Derneği. 2009.
6. Herrmann B, Mortsch F, Berg C, Weischer T, Mohr C, Mann K. Acromegaly: a cross-sectional analysis of the oral and maxillofacial pathologies. *Experimental and clinical endocrinology & diabetes*. 2011;119(01):9-14.
7. Kristof RA, Grote A, Redel L, Neuloh G, Klingmüller D, Schramm J. The common consensus criteria have high predictive values for long-term postoperative acromegaly remission. *Acta neurochirurgica*. 2011;153(1):19-25.
8. Black PM, Zervas NT, Candia GL. Incidence and management of complications of transsphenoidal operation for pituitary adenomas. *Neurosurgery*. 1987;20(6):920-4.