



EFFECTS OF PLANNING WITH PREOPERATIVE THREE DIMENSIONAL MODELLING IN TRANSSPHENOIDAL ENDOSCOPIC PITUITARY SURGERY ON SURGICAL SUCCESS

Neurosurgery

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ABSTRACT

Objective: To investigate the effect of three-dimensional (3D) printer technology on transsphenoidal endoscopic pituitary surgery.

Material and Method: Preoperative Paranasal CT images of 12 patients who were applied transsphenoidal endoscopic surgery due to Pituitary Adenoma were printed with 3D printer after reconstruction and measurements were made by surgical team on bone structure and endoscope-guided simulation was made.

Findings: Average operation duration of the patients who had 3D print modeling was 106 ± 13.52 minutes and operation lasted 152 ± 24.14 minutes in the patients who didn't have modeling. Average hospitalization duration of the patients who had 3D print modeling was 3 ± 1.42 days and hospitalization duration was 6 ± 2.64 days in patients without modeling. Hospitalization and operation durations of the patients who were operated with 3D print modeling were detected shorter and found to be statistically significant ($p < 0.01$).

Result: Preoperative planning with 3D modeling increased the mastery on individual surgical anatomy and decreased complication rate, operation duration and hospitalization duration.

KEYWORDS

Endoscopic Pituitary Surgery, 3 Dimensional Printer, Transsphenoidal

INTRODUCTION

Today, Transsphenoidal endoscopic technique is the technique most commonly used in pituitary surgery. The success of this surgery depends on the mastery on surgical anatomy. Many complications may occur due to nerve and vascular injury in suprasellar or parasellar area during surgery (1).

3D print technology provides the transformation of cross-sectional CT images into more realistic and visualized three dimensional physical objects (2) and this makes the pituitary surgery anatomy preoperative mastery easier.

Creating a model presenting transsphenoidal endoscopic surgical anatomy through individual 3D printing, the objective in our study was to increase surgical success through preoperative simulation and to decrease complication risk.

MATERIALS AND METHODS

Preoperative paranasal sinus CT images of 12 patients operated with transsphenoidal endoscopic technique due to pituitary adenoma in İzmir Katip Çelebi University Atatürk Training and Research Hospital Brain surgery clinic between 2017 and 2018 were taken with Toshiba Aquilion LB v.6 (Toshiba Medical Systems, Tokyo, Japan) device. After reconstructing with 120 kVp, 200 mAs, 120 mA, 300 mm FOV, 512×512 grid thickness and 1 mm cross-section thickness protocol, STL format was formed for CT data using 3D Slicer v. 4.8.1 software and they were printed with Ultimaker 3 Extended 3D printer. Then, in the materials printed with the surgery team, preoperative measurements were taken for nasal cavity, sphenoid sinus and opening, nasolacrimal channel, internal carotid artery, optic channel, superior nasal concha, medium nasal concha and sphenopalatine foramen areas and the simulation was made for the operation. Then transsphenoidal endoscopic hypophysectomy operation was made in line with these data. Operation durations, hospitalization durations and complication numbers were checked and compared to the values of the 20 patients who were applied transsphenoidal endoscopic hypophysectomy without 3D software by the same operation team before.

Exclusion criteria in the study: Patients with paranasal sinus surgery and major head trauma story were excluded from the study.

Patients were followed-up for six months. SPSS v23 software was used for the statistical analyses of study data. T test and chi-square (McNemar chi square) tests were used in dependent groups for data comparison. Processing the data acquired through these tests and their median value, these were transferred into the statistics program. $p < 0.05$ was regarded as statistically significant.

RESULTS

Out of 12 patients who had 3D printing modeling, four were female (33.3%) and eight were male (67.7%). The ages changed between 24 and 53 (average: 37.50 ± 9.43). Weighted pathology results were prolactinoma in six (50%) and non-functional in four patients (33.3%) and gh (8.35%) and ACTH releasing adenoma (8.35%) both in one patient.

Average operation duration of the patients who had 3D print modeling was 106 ± 13.52 minutes and the operation lasted 152 ± 24.14 minutes in patients who didn't have modeling (Table-1). This difference was found statistically significant ($p < 0.01$).

Average hospitalization duration of the patients who had 3D print modeling was 3 ± 1.42 days and the hospitalization lasted 6 ± 2.64 days in patients who didn't have modeling (Table-1). This difference was found statistically significant ($p < 0.01$).

TABLE-1 Operation duration and hospitalization duration

	Those who had 3D print modeling	Those who were applied Classical Surgery	P value
Operation Duration	106 ± 13.52	152 ± 24.14	$p < 0.01$
Hospitalization Duration	3 ± 1.42	6 ± 2.64	$p < 0.01$

Complication didn't occur in any of the patients who had 3D print modeling. Rinore occurred in two and pneumocephaly occurred in one of the 20 patients who didn't have modeling.

DISCUSSION

Transsphenoidal endoscopic method is the most common method used in pituitary surgery and this method becomes more common every day (3). The success of Transsphenoidal Endoscopic pituitary surgery depends on the mastery on surgical anatomy. Many complications may occur due to nerve and vascular injury in suprasellar or parasellar area during surgery (1).

3D print method is one of the most popular areas of technology recently. It is commonly used in medical education and the evaluation of surgical methods (4,5,6). In some studies made, successful cranial models were formed with 3D printing method (7,8). In endoscopic transsphenoidal surgery field, 3D printing and modeling method studies were focused on education field alternative to cadaver studies and no studies were made on individual modeling for the patient in pituitary surgery (9,10,11,12).

Although the complication ratios occurring during transsphenoidal pituitary surgery decrease in years, 56.4% of the complications occur due to anatomic orientation disorder (13). Making patient specific anatomic and surgical simulation before the surgery with 3D printing method, anatomic mastery was increased in our study and complication didn't occur in the surgery applied patients with the contribution of this modeling.

Average surgery duration was detected 152 ± 34.14 minutes in the patients operated with classical endoscopic transsphenoidal pituitary surgery method. Average surgery duration was detected as 106 ± 13.52 minutes in the cases we applied 3D printing method and modeling. This difference was found statistically significant ($p < 0.01$). As in other neuroanesthesia applications, longer operation durations in endoscopic transsphenoidal pituitary surgical anesthesia applications increase complication risk during and after operation (14). Thus we think that shortening of operation durations with the use of 3D technology will also shorten complication rates in the surgery of pituitary adenoma among neuroendocrinal diseases.

Hospitalization duration in patients operated with classical endoscopic transsphenoidal pituitary surgery method was found 6 ± 2.64 days and this duration was found in line with literature (15,16). Hospitalization duration was detected as 3 ± 1.42 minutes in the cases we applied 3D printing method and modeling. This difference was found statistically significant ($p < 0.01$). Use of 3D printing method lowered cost per patient by shortening hospitalization duration. When 3D printing and hospitalization duration costs per patient were evaluated, shortened hospitalization duration was observed to be more profitable.

CONCLUSION

It was detected that planning and simulating through 3D printing and modeling method before endoscopic transsphenoidal pituitary surgery increased the individual mastery on surgical anatomic area, shortened operation duration, decreased number of complications, shortened hospitalization duration and decreased cost per patient. Improvement of 3D technology by being used in larger studies and making individual 3D surgical anatomic modeling in clinics where pituitary surgery will be applied will both increase surgical success and decrease total cost.

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