

## **Three Dimensional Reconstruction of Late Post-Traumatic Defect in the Anterior Wall of the Frontal Sinus by Custom Implant of Ultrahigh Molecular Weight Polyethylene**

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Received: December 01, 2020

Published: December 16, 2020

### **Abstract**

One case of young female who had an accident which caused a post-traumatic fracture of the anterior wall of the frontal sinus is described. The post-traumatic deformity of the anterior wall being reconstructed by custom made ultrahigh molecular weight polyethylene implant. The aim of this presentation is to show one of the method and material choice for cranioplasty to obtain aesthetic result.

**Keywords:** Craniomaxillofacial surgery; Frontal sinus wall fracture; Frontal sinus injury; Forehead injury; Facial deformation; Cranioplasty; Individual designed implant; Ultrahigh molecular weight polyethylene

### **Introduction**

Today, along with the development of automobile industry, an increase of hospitalized patients in the Department of Maxillofacial Surgery who have suffered a car accident is notice. The head and neck injuries following the road traffic crashes are the most common cause of morbidity and mortality in most developed and developing countries [1]. The traffic accidents were the cause of approximately 20% maxillofacial injuries [2]. The majority of frontal sinus wall fractures are the result of high – velocity injuries, such as motor vehicle accidents, assaults, and sporting incidents [3]. The incidence of frontal sinus injury is estimated between 6 and 12 % of all craniofacial fractures [4]. The frontal sinus trauma is not rare and it is 8% of the facial fractures [5].

It is important to keep in mind that many patients refer to the service after a few days after the car accident. In this case surgeons have to face up to the delayed treatment which is always a challenge to obtain satisfactory effects. The patients are at risk of prolonged hospital stays. Moreover in many cases they need two or more surgical procedures as it was in the case of our patient. This is because there is a lack of maxillo-facial surgeon in the hospital to which the patient was transported after the accident.

We also have to take into account that nowadays not only the functional results make an importance, but also aesthetic results. Computer and software development meets that need. One example of advanced system is Computer-Aided Design and Manufacturing (CAD/CAM). Computer Aided Design (CAD) is the process of creating, modifying, analyzing, optimizing a design [6] surgeons can design the implants themselves [7]. When this part of the design is finished, we move

on to the next stage. In order to build physical models and implants such as a stereo lithograph, we transfer data to the computer- aided manufacturing system (CAM) [8]. This techniques have facilitated the rapid and precise construction of customized implants. The computer-assisted reconstruction of maxillofacial defects could provide a more predictable aesthetic outcome [9], whose postoperative position can be confirmed by CT [10]. The use of 3D imaging and CAD/CAM technology aids in the diagnosis and treatment of facial deformities which can arise after traffic injuries as was in our case, but also can be a result of malformation or iatrogenic surgical defects. CAD/CAM systems also allow customized mandibular condylar implants to be designed and fabricated with the highest degree of fit and then to be perfectly fixed to the surrounding bones [11]. Many authors describe the practical application of this computer program to create alloplastic implants for example in orbital reconstructive surgery where the custom implant covering the bone defect in the lower orbital wall. [12].

There are various kinds of material type such as titanium (solid or powder), High-Density Poly Ethylene (HDPE), Poly Ether Ether Ketone (PEEK), hydroxyapatite (HA) , poly –DL-lactic acid (PDLLA), Poly Lactide- co – Glycoside Acid (PLGA), calcium phosphate, polyethylene includes porous polyethylene (PPE) and Ultra-High Molecular Weight Poly Ethylene (UHMW-PE). We decided to use the last one mentioned above, because has several unique properties including high impact strength and a low friction coefficient that result in self-lubricating and thus non-sticking surfaces after processing [13]. It is worth mentioning that once only autogenously grafts were used, but due to their drawbacks nowadays they are rarer used. Autogenously bone graft often undergoes significant resorption and unpredictable rendering it unreliable for long- term

augmentation [14].

## Case Report

A 21-year-old woman was admitted to the Out-Patient Department of Maxillofacial Surgery in July 2020 with a post-traumatic deformity of the upper part of the facial skull. The patient had a road accident 3 years ago (09/04/2017). As a result of the injury, comminuted fractures of the middle part of the frontal bone appeared, covering the anterior and posterior walls of the frontal sinus, with the displacement of the fragments to the anterior cranial fossa, with numerous bone fragments pressed into the frontal sinus, with fractures of walls of the both orbits and maxillo-ethmoidal complex, with fractures of the walls and sphenoid septum including the sella turcica. The day of the injury, the patient was operated on by the neurosurgeons. On day 10 after the injury, mini-plate osteosynthesis of the jaw fracture was performed by maxillo-facial surgeon. In the following years 2018 and 2019, the patient was hospitalized in the Department of Plastic Surgery, where adipose tissue was transplant to reconstruct the shape of the forehead. In July 2020, at the Department of Maxillofacial Surgery of the Medical University of Lodz, reconstruction of the anterior wall of the frontal sinus was performed with an individual implant due to insufficient results of the autogenous fat transplantation procedure.

The custom implant was made on the basis of computed tomography from ultrahigh molecular weight polyethylene (UHMWPE) by Bionano Park of Lodz, Poland. It is worth mentioning that the coronal skin flap was damaged by old traumatic scars in the frontal area. The collapse range was up to 1 cm in forehead, the area of the deformation was 4 to 6 cm. The deformation is illustrated in the fig. 1. Coronal approach was used to reach the deformity located in the anterior wall of the frontal sinus. After placing the individual implant in an appropriate position, it was found to be perfectly stable and adhered to the bone in the whole area. It was fixed using 2 screws 1.5 mm in diameter and 6 mm of length on the both sides of the implant, thereby immobilizing it. After surgical treatment a satisfactory clinical and, above all, aesthetic effect was obtained. The post-operational period was uneventful, drainages were removed in second day, and the patient was discharged home on the third day after the procedure.

## Discussion

Post-traumatic deformity of the facial skull is a major reconstructive issue related to functional and aesthetic outcomes. Especially for young people, the quality of life after an accident is important; they struggle with the problems of self-acceptance and removal from the society. Autogenously bone reconstruction is very difficult and must sometimes be repeated to obtain a good result. Individual implants made of ultrahigh molecular weight polyethylene have been used in the Maxillofacial Sur-

gery Clinic for more than 10 years and have many advantages as a material that precisely reconstruct the anterior wall of the frontal sinus. Moreover, the material itself, being a biocompatible, cheap, glossy, does not cause late complications, implantation is much easier than bone grafting and provide immediate therapeutic success. Nevertheless, it is worth noting a certain disadvantage that can be observed from one's own clinical experience - the pre-surgical procedure is very time consuming.

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