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Surgical management of maxillofacial fibrous dysplasia under navigational guidance

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Abstract

Fibrous dysplasia is a benign and slowly progressive disorder of bone in which normal cancellous bone is replaced by immature woven bone and fibrous tissue. Precise excision of the lesion is crucial to restore function and aesthetics. We present our experience using surgical navigation technology for the recontouring of the faces of 8 patients with maxillofacial fibrous dysplasia who were treated from 2012–2013, all of whom were thought suitable for surgical recontouring. Preoperative computed tomography (CT) scans were used to make a virtual plan based on the patient's mirrored anatomy. During the operation we fixed a rigid digital reference frame to the patient's forehead or mandible, depending on the site of the lesion. The patient and the virtual image were matched through an individual recording technique. A pointing device was in constant use to find out whether the extent of resection was consistent with the preoperative design, and we assessed the surgical outcome by fusion of the preoperative planning and postoperative CT reconstruction images. The acquisition of the data sets was uncomplicated, and the use of surgical navigation improved the safety and the accuracy of the recontouring. There were no complications during 1–2 years follow up. Navigational guidance based on a virtual plan is safe and accurate, and is of value in the management of maxillofacial fibrous dysplasia.

Keywords: Surgical navigation; Fibrous dysplasia; Recontouring; Accuracy

Introduction

Fibrous dysplasia is a benign and slowly progressive disorder of bone in which normal cancellous bone is replaced by immature woven bone and fibrous tissue. It tends to become self-limiting after puberty.[1,2] The abnormalities disrupt the normal architecture of the bone and can lead to various complications such as pain, osteoarthritis, deformities, pathological fractures, and nerve compression syndromes.[3]

Treatment of maxillofacial fibrous dysplasia depends on the patient's age, disease-related dysfunction, and the extent and site of the lesion. For severe lesions with obvious deformity, modern surgical techniques allow aggressive but definitive treatment with good functional and aesthetic results.[4] However, the complex 3-dimensional anatomy and geometry of the human skull and face, together with the fact that the normal anatomy is often changed by the deformity, make it difficult to recontour the region.

Preoperative designs have been widely used to achieve satisfactory surgical outcomes, yet more efficient and precise operative feedback is required. Surgical navigation is a promising new technique that can improve surgical accuracy and safety during operation by providing constant feedback.

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This illustrates the cohesion between the operative process and the preoperative design, as well as the relation between the surgical area and vital anatomical structures.[5]

We describe the intraoperative navigational device that we find helps our accuracy and safety during operations for fibrous dysplasia, and analyse its advantages and shortcomings.

Patients and methods

We studied 8 subjects with fibrous dysplasia who were treated surgically with the aid of the navigational device from August 2012 to July 2013 at the Institute and Hospital of Stomatology, Nanjing University Medical School. Facial asymmetry was their major complaint, and they had no disease-related dysfunction. All were judged to be suitable for recontouring procedures. There were 4 men and 4 women, mean (SD) age 26 (10.5) years, and the mean (range) duration of the dysplasia was 7 (3–10) years. In two of the cases the left mandible was affected, and in the other six it was the maxilla (five on the right and one on the left). Patients were followed up for 1–2 years.

Spiral computed tomography (CT) (GE Discovery CT750, Wisconsin, USA) was used to obtain both preoperative and postoperative images. Multifunctional Surgical Navigation Systems were used for all patients and consisted of a computer-assisted surgical software platform and a navigation workstation.

Imaging/preoperative design

A preoperative thin-cut (0.625 mm) spiral CT scan was obtained from each patient, imported into the Windows-based computer workstation of the navigation system using the digital imaging and communications in medicine (DICOM), and a 3-dimensional image was developed. The median sagittal plane was chosen as the reference plane. The healthy side was mirrored on to the affected side and the position altered manually (Fig. 1). The resection area was outlined through image fusion in subtraction mode and improved manually. The amount of the lesion to be resected was displayed in a different colour (Fig. 2). After preoperative planning, both the original CT data and the virtual reconstruction model were transferred to the intraoperative navigation systems.

Recording and navigation

Depending on the site of the lesion, the digital reference frame was fixed rigidly to the patient's forehead or mandible for the infrared tracking camera of the navigation system. The patient and the virtual image were matched through markers including tooth cusps and bony landmarks using paired-points and surface matching techniques. We pinpointed the corresponding anatomical landmarks on the patient as insisted by the computer, and the discrepancy was then analysed from 3 planes, and a final discrepancy achieved in three dimensions. We went over this procedure twice and a mean value was accepted as the discrepancy

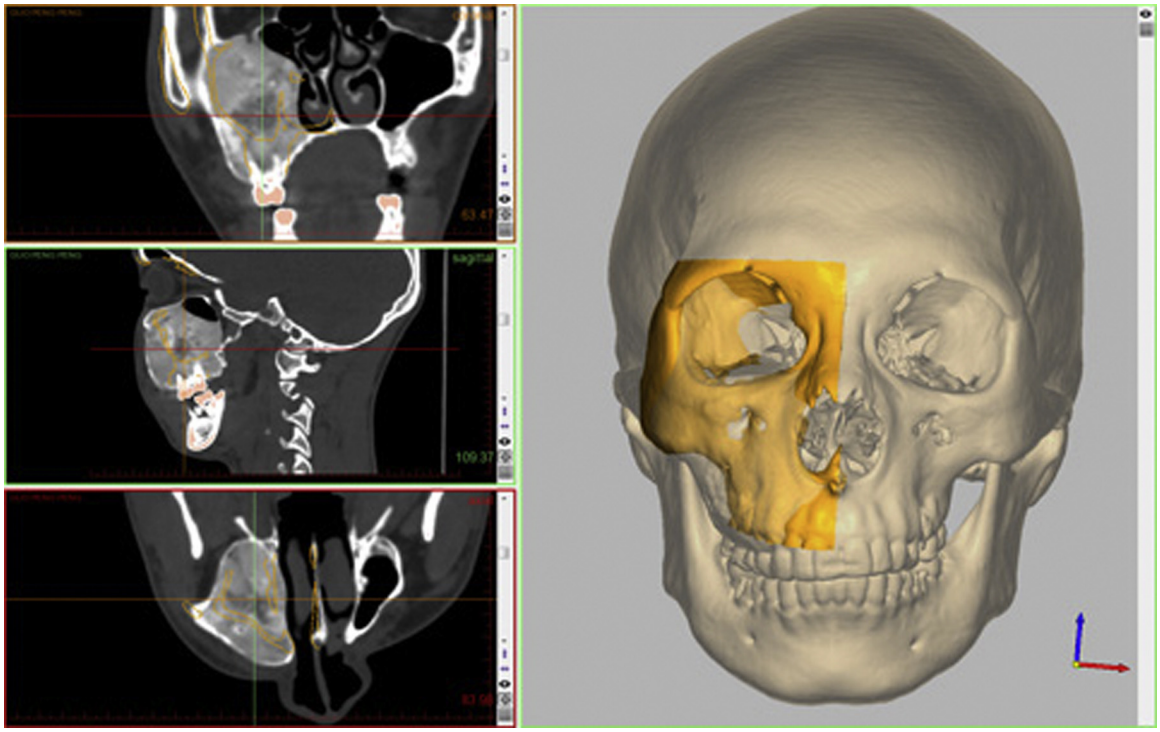

Fig. 1. The computed tomographic (CT) data was put into the workstation. The reconstructed CT image gives a sense of the 3-dimensional shape of the lesion that accounts for the clinical appearance. The sagittal plane was chosen as the reference plane and the healthy side was mirrored on to the affected side and better placed manually. The mirrored image was shown in pale yellow while the original image was shown in deep yellow.