Journal of Cranio-Maxillo-Facial Surgery 42 (2014) 1000–1004

Contents lists available at ScienceDirect

Journal of Cranio-Maxillo-Facial Surgery

journal homepage: www.jcmfs.com

Operability score: An innovative tool for quantitative assessment of operability in comparative studies on surgical anatomy

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ARTICLE INFO

Article history:
Paper received 19 December 2012
Accepted 6 January 2014

Keywords:
Operability
Comparative study
Surgical anatomy

ABSTRACT

Objectives: Comparative anatomical studies have proved to be invaluable in the evaluation of advantages and drawbacks of single approaches to access established target areas. Approach-related exposed areas do not necessarily represent useful areas when performing surgical manoeuvres. Accordingly the concept of "operability" has recently been introduced as a qualitative assessment of the ability to execute surgical manoeuvres. The authors propose an innovative model for the quantitative assessment of the operability, defined as "operability score" (OS), which can be effectively and easily applied to comparative studies on surgical anatomy.
Methods: A microanatomical study was conducted on six cadaveric heads.
Results: Morphometric measurements were collected and operability scores in selected target points of the surgical field were calculated. As illustrative example, the operability score was applied to the extradural subtemporal transzygomatic approach (ESTZ).
Conclusion: The operability score is effective in grading system of surgical operability, and instruments manipulation capability. It is a useful tool to evaluate, in a single approach, areas that can be exposed, and to quantify how those areas are suitable for surgical manoeuvres.

1. Introduction

Comparative anatomical studies have proved to be invaluable in the evaluation of the advantages and the drawbacks of single approaches to access established target areas (Ammirati et al., 2002; Tanriover et al., 2006; Filipce et al., 2009; Pillai et al., 2009; Seker et al., 2010; Lee et al., 2011; Aktas et al., 2012; Yilmazlar et al., 2012).

The selection of a surgical approach not only involves a consideration of access to a defined target, but also must involve a consideration of the trajectory to the target, and the manoeuvrable space provided at the target's working area. Approach-related exposed areas do not necessarily represent useful areas when performing surgical manoeuvres (Filipce et al., 2009; Pillai et al., 2009; Gagliardi et al., 2012a, 2012b). Based on this observation there has evolved a need to compare surgical approaches to define the relative effectiveness in the ability to perform surgical manoeuvres among the various approaches. So far this definition was limited to a qualitative parameter defined as "operability" or "surgical freedom" (Filipce et al., 2009; Pillai et al., 2009). This parameter was encoded as the ability to execute surgical manoeuvres in a defined point of the surgical field, which is assessed intraoperatively by senior surgeons (Filipce et al., 2009). Individual technical skill however, is a highly inconstant variable, making data obtained by this evaluation system extremely difficult to compare(Mucke et al., 2013).

The authors propose an innovative model for the quantitative assessment of the operability, defined as "operability score" (OS), which can be easily applied to comparative studies of surgical anatomy. The practical application of the score system was illustrated by the Extradural Subtemporal Transzygomatic (ESTZ) approach. The ESTZ approach is a lateral extradural route that provides access the clival region. This technique provides a wide surgical exposure, however the operability at the critical target areas of the surgical field can be very constrained. This approach presents major limitations in terms of operability, due to the narrow and deep surgical corridor, and the risk of injury to the temporal lobe.

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http://dx.doi.org/10.1016/j.jcms.2014.01.024

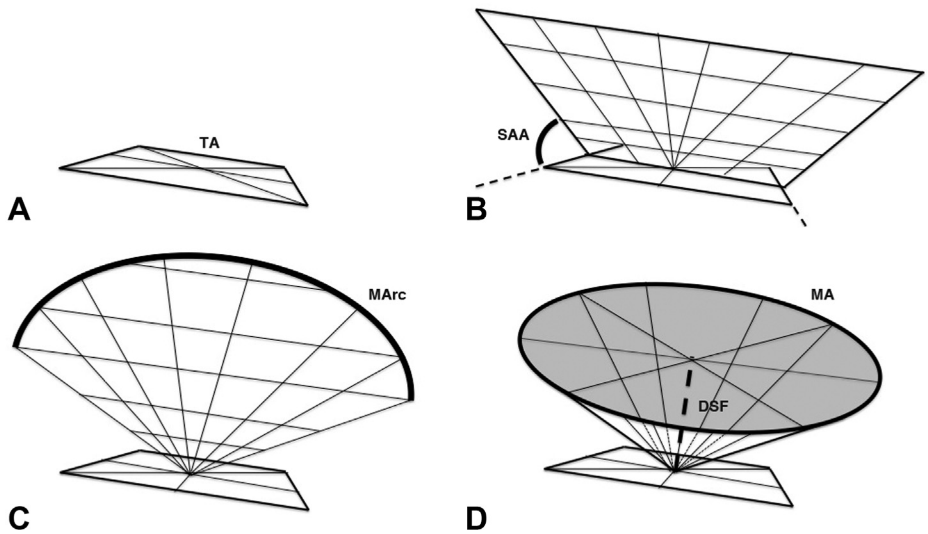

Fig. 1. Schematic illustration showing the geometrical rationale of the OS. A: Target area; B: Surgical angle of attack; C: Manoeuvrability arc; D: Manoeuvrability area and depth of the surgical field. DSF = Depth of the Surgical Field; MA = Manoeuvrability Area; MArc = Manoeuvrability Arc; SAA = Surgical Angle of Attack; TA = Target Area.

2. Material and methods

2.1. Materials

The study was performed at the Anatomical Laboratory of the Department of Neurosurgery at the George Washington University (Washington, DC, USA). Silicone-injected cadaveric heads were prepared using standard formaldehyde fixation techniques.

2.2. Microscope and endoscope

The microsurgical techniques and the morphometric measurements were conducted using a Zeiss OPM 1 FC microscope (Carl Zeiss, Oberkochen, Germany) and a rigid endoscope, 4 mm in diameters and 18 cm in length, with 0-, 30- and 45-degree lenses. A Midas Rex drill (Midas Rex, Fort Worth, TX, USA) was used for all bone drilling.

The morphometric measurements were accomplished with graded scales. The mean value of the measurements were recorded and served as the basis for the final tabulated data. Anatomical areas exposed by the surgical approaches were calculated using ImageJ 1.37a software (National Institute of Health).

2.3. Surgical technique

On three cadaveric heads a right-sided ESTZ approach was performed, on the other three a left-sided one. Surgical technique has already been described in a previous report (Gagliardi et al., 2012a, 2012b).

3. Results

3.1. Score system

The *operability*, as previously qualitatively defined as the ability to execute surgical manoeuvres on the visualized area (Filipce et al., 2009) was now quantified at selected points of critical importance in the surgical field, resulting in an operability score (OS). The score was calculated in every point considering three quantitative independent variables: the surgical angle of attack, the manoeuvrability arc, and the depth of the surgical field (Fig. 1).

The ***surgical angle of attack***, as measured by a goniometer, was defined as the angle of incidence of the surgical corridor in selected points of the surgical field (Gonzalez et al., 2002). To measure the angle, the stationary arm of the goniometer was placed on the plane identified by the target point, and the movable arm was opened according to the axis of the surgical corridor, as shown in Fig. 1B.

The ***manoeuvrability arc***, measured by a goniometer, was defined as the degree of freedom in manipulating surgical instruments in selected points of the surgical field. To measure the range of motion of an instrument at the target point, the fulcrum of the goniometer was placed over the point of interest and the movable arms were opened according to the major diameter of the manoeuvrability area, as shown in Fig. 1C.

The *depth of the surgical field*, was measured directly with a ruler on the axis of the surgical corridor and was defined as the distance between a target point and the manoeuvrability area, as shown in Fig. 1D.

The *manoeuvrability area* was defined, previously as the cross section surface area of the surgical corridor at its narrowest part (Gagliardi et al., 2012a, 2012b). It is represented by an ellipsoid limited by anatomical landmarks, and geometrically defined by two main diameters, as shown in Fig. 1D.

A score either 0 or 1 was assigned to every quantitative variable. Specifically for the depth of the surgical field the assigned score was 0 if more than 5 cm in depth and for those less than 5 cm, the assigned score was 1. For a manoeuvrability arc, a calculated value of more than 45°, the assigned score was 1 and for those less than 45°, the assigned score was 0. A surgical angle of attack wider than 60° the assigned score was 1, and for those less than 60° in width the assigned score was 0.

The sum of these three scores assigned to the single variables at a selected point of the surgical field yielded the calculated the OS in that point. The range of the OS was from a minimum of 0 to a maximum of 3.

3.2. Conizing effect

As conizing effect we considered the index defined by dividing the manoeuvrability area (defined in a previous report as the cross section area at the narrowest part of the surgical corridor)