Surgical Freedom Evaluation During Optic Nerve Decompression: Laboratory Investigation

Alberto Di Somma[1], Norberto Andaluz[2], Steven L. Gogela[2], Luigi Maria Cavallo[1], Jeffrey T. Keller[2], Alberto Prats-Galino[3], Paolo Cappabianca[1]

■ BACKGROUND AND OBJECTIVE: **Various surgical routes have been used to decompress the intracanalicular optic nerve. Historically, a transcranial corridor was used, but more recently, ventral approaches (endonasal and/or transorbital) have been proposed, individually or in combination. The present study aims to detail and quantify the amount of bony optic canal removal that may be achieved via transcranial, transorbital, and endonasal pathways. In addition, the surgical freedom of each approach was analyzed.**

■ METHODS: **In 10 cadaveric specimens (20 canals), optic canals were decompressed via pterional, endoscopic endonasal, and endoscopic superior eyelid transorbital corridors. The surgical freedom and circumferential optic canal decompression afforded by each approach was quantitatively analyzed. Statistical comparison was carried using a nonpaired Student *t* test.**

■ RESULTS: **An open pterional transcranial approach allowed the greatest area of surgical freedom (transcranial, 109.4 ± 33.6 cm^2; transorbital, 37.2 ± 4.9 cm^2; endonasal homolateral, 10.9 ± 5.2 cm^2; and endonasal contralateral, 11.1 ± 5.6 cm^2) with widest optic canal decompression compared with the other 2 ventral routes (transcranial, 245.2; transorbital, 177.9; endonasal, 144.6). These differences reached, in many cases, statistical significance for the transcranial approach.**

■ CONCLUSIONS: **This anatomic contribution provides a comprehensive evaluation of surgical access to the optic canal via 3 distinct, but complementary, approaches: transcranial, transorbital, and endonasal. Our results show that, as expected, a transcranial approach achieved the widest degree of circumferential optic canal decompression and the greatest surgical freedom for manipulation of surgical instruments. Further surgical experience is necessary to determine the proper surgical indication for the transorbital approach to this disease.**

INTRODUCTION

Over the past few decades, several approaches have been proposed for decompression of the optic canal.[1-18] Historically, transcranial routes (i.e., pterional, supraorbital, and orbitozygomatic) were preferred for optic nerve decompression. In an effort to reduce morbidity, focus has shifted toward minimally invasive approaches, with endonasal and transorbital corridors gaining increasing support in the current literature.[7,19-22] Recent anatomic contributions have eloquently quantified the extent of bony optic canal decompression that can be obtained via ventral[19] and transcranial approaches, both individually and in combination. The extent to which a surgeon may maneuver operating instruments using these approaches has not yet been analyzed. This concept is commonly described in the literature as surgical freedom (i.e., the maximum range of surgical instruments within the operative field).[23] Given the limited operative field and the abundance of critical neurovascular structures in the region, a detailed analysis of the exposure afforded by each of these routes is lacking to refine the indications and support the choice of approach according to the disease causing optic nerve compression.

Key words
- Endoscopic endonasal
- Endoscopic transorbital
- Optic nerve
- Quantitative analysis
- Surgical freedom
- Transcranial optic nerve decompression

From the [1]Division of Neurosurgery, School of Medicine and Surgery, Universita degli Studi di Napoli Federico II, Naples, Italy; [2]Department of Neurosurgery, University of Cincinnati College of Medicine, Comprehensive Stroke Center at UC Neuroscience Institute, Mayfield Clinic, Cincinnati, Ohio, USA; and [3]Laboratory of Surgical Neuroanatomy, Faculty of Medicine, Universitat de Barcelona, Barcelona, Spain

To whom correspondence should be addressed: Alberto Di Somma, M.D. [E-mail: albertodisomma87@gmail.com]

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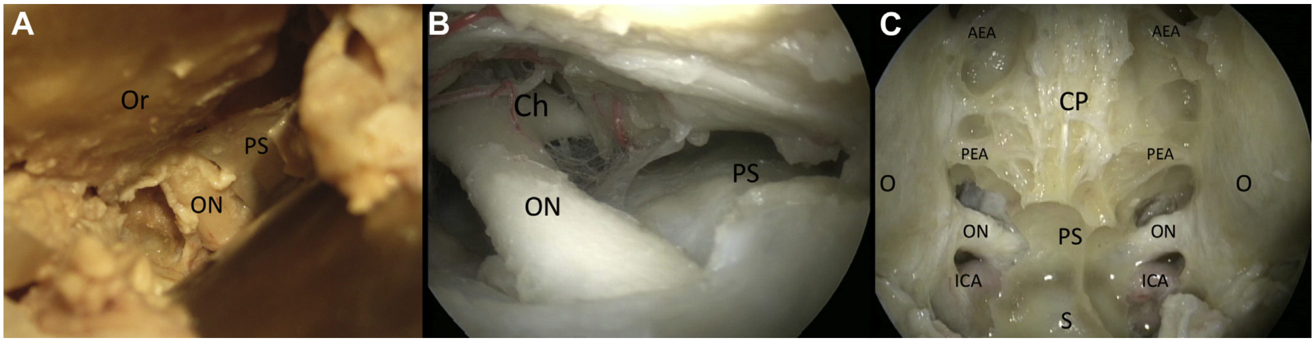

Figure 1. Anatomic cadaveric pictures showing optic nerve decompressed via pterional (**A**), endoscopic transorbital (**B**), and endoscopic endonasal (**C**) paths. The relationships with the surrounding structures are highlighted. AEA, anterior ethmoidal artery; Ch, optic chiasm; CP, cribriform plate; ICA, internal carotid artery; O, orbit; ON, optic nerve; Or, orbital roof; PEA, posterior ethmoidal artery; PS, planum sphenoidale; S, sella.

A quantitative understanding of surgical freedom combined with recent anatomic data could provide significant insight when determining the best approach for optic canal decompression for various diseases. This is the basis for the present laboratory investigation, in which we carried out a quantitative comparison of surgical freedom when approaching the optic canal via 3 different routes: transcranial, transorbital, and endonasal. In addition, we sought to provide a volumetric analysis of the bony removal afforded by each approach and a qualitative assessment of the effectiveness of each route, both alone and in combination. To our knowledge, this is the first contribution to the literature providing a comprehensive evaluation of surgical access to the optic canal via these 3 distinct but complementary paths.

METHODS

Ten adult cadaveric specimens, without known intracerebral abnormality, were dissected. Anatomic dissections were performed at the Laboratory of Neuroanatomy (Goodyear Laboratory) of the University of Cincinnati (Ohio, USA) and at the Laboratory of Surgical Neuroanatomy of the University of Barcelona (Spain). Cadavers were registered with the Brainlab Curve (Brainlab, Feldkirchen, Germany) for the acquisition of landmark points used in the calculation of operative exposure. A registration correlation tolerance of 2 mm was considered acceptable.

Dissections began macroscopically and then proceeded microscopically using a Leica operating microscope (Leica Microsystems Inc., Buffalo Grove, Illinois, USA). Endoscopy was performed using a rigid 4-mm-diameter endoscope, 14 cm long, with 0° and 30° rod lenses (Stryker, Kalamazoo, Michigan, USA). These pieces of equipment were connected to a light source through a fiberoptic cable and a video camera. Images were captured using a high-definition digital video system (Stryker). A high-speed drill and craniotome were used for bony removal. In 5 specimens, both transcranial and endonasal approaches were performed, whereas in the remaining 5 cadaveric heads both the transorbital and endonasal routes were evaluated.

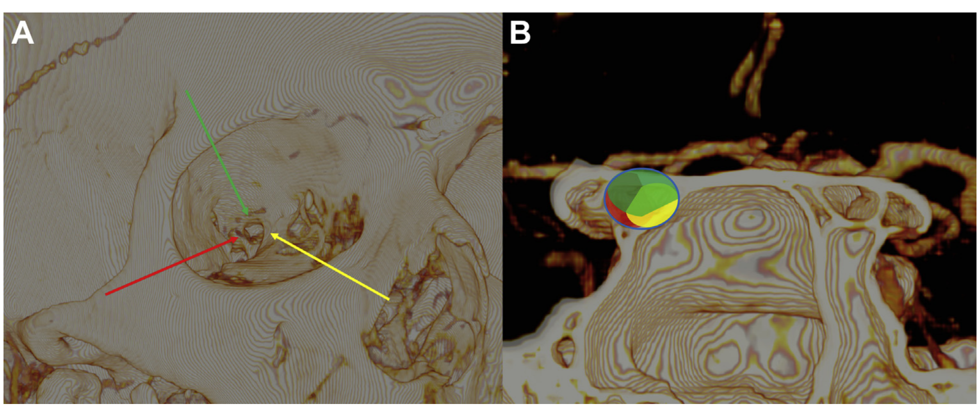

Figure 2. Three-dimensional representation obtained with Osirix MD software (OsiriX [Osirix Foundation]) of the optic nerve decompression via different surgical routes (**A**). The degree of optic canal removal is shown in coronal section (**B**). Transcranial pterional (*green*); transorbital (*red*); endonasal (*yellow*).