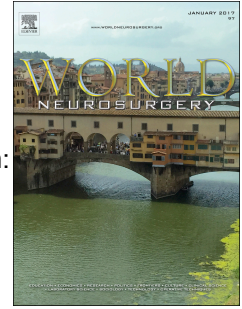


Journal Pre-proof



Eliciting smile and laughter during intraoperative electrical stimulation of the cingulum:
Surgical scenario

Leticia Fernández, M.D., Carlos Santos, M.D., Elsa Gómez, S.T, Carlos Velásquez,
M.D., Juan Martino, M.D., Ph.D.

PII: S1878-8750(19)32532-X

DOI: <https://doi.org/10.1016/j.wneu.2019.09.101>

Reference: WNEU 13400

To appear in: *World Neurosurgery*

Received Date: 6 August 2019

Revised Date: 17 September 2019

Accepted Date: 18 September 2019

Please cite this article as: Fernández L, Santos C, Gómez E, Velásquez C, Martino J, Eliciting smile and laughter during intraoperative electrical stimulation of the cingulum: Surgical scenario, *World Neurosurgery* (2019), doi: <https://doi.org/10.1016/j.wneu.2019.09.101>.

This is a PDF file of an article that has undergone enhancements after acceptance, such as the addition of a cover page and metadata, and formatting for readability, but it is not yet the definitive version of record. This version will undergo additional copyediting, typesetting and review before it is published in its final form, but we are providing this version to give early visibility of the article. Please note that, during the production process, errors may be discovered which could affect the content, and all legal disclaimers that apply to the journal pertain.

© 2019 Elsevier Inc. All rights reserved.

1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
19
20
21
22
23

TITLE PAGE

TITLE OF THE PAPER

Eliciting smile and laughter during intraoperative electrical stimulation of the cingulum:
Surgical scenario

AUTHOR'S NAMES

Leticia Fernández, M.D.¹, Carlos Santos, M.D.², Elsa Gómez, S.T.³, Carlos Velásquez,
M.D.², Juan Martino, M.D., Ph.D.²

Affiliations

¹Department of Neurological Surgery, Hospital Universitario Araba – Santiago Apóstol.
Olagibel 29, 01004. Vitoria (Alava, Basque Country). Spain.

Departments of ²Neurological Surgery and ³Psychiatry, Hospital Universitario Marqués de
Valdecilla and Fundación Instituto de Investigación Marqués de Valdecilla. Avenida
Valdecilla s/n, 39008. Santander (Cantabria). Spain.

*All authors contributed equally to this work.

Corresponding author at all stages of refereeing and publication

Leticia Fernández, M.D. Department of Neurological Surgery, Hospital Universitario Araba –
Santiago Apóstol. Olagibel 29, 01004. Vitoria (Alava, Basque Country). Spain. Phone:
+34645717692; Email: leticiafernandeztranche@gmail.com

24 **Corresponding author at post-publication stage**

25 Juan Martino, M.D., Ph.D. Department of Neurosurgery, Hospital Universitario Marqués de
26 Valdecilla (HUMV) and Fundación Instituto de Investigación Marqués de Valdecilla (IDIVAL).
27 Avda. Valdecilla s/n, 39008, Pabellón 19 bajos, Santander (Cantabria), Spain. Phone:
28 942202701; Fax: 942203478; Email: juan.martino@hotmail.com

29

30 **KEYWORDS**

31 Astrocytoma; awake craniotomy; cingulum; intraoperative electrical stimulation; laughter

32

33 **SHORT TITLE**

34 The cingulum and laughter

35

36 **OTHERS**

37 **Patient consent:** The patient gave informed consent to the procedure and signed the consent
38 to publication of materials (videos, images or another clinical or genetic information) in
39 journals. These informed consents were approved by the Institutional Review Board (Comité
40 de Ética de la Investigación con Medicamentos de Cantabria, IDIVAL).

41

42 **Financial support and industry affiliations:** none. This research did not receive any specific
43 grant from funding agencies in the public, commercial, or not-for-profit sectors.

44

45 **Declarations of interest:** none.

1 ABSTRACT

2 Laughter has a major role in daily life social interactions and consequently, its biological
3 bases have been previously studied. Nevertheless, its cerebral representation remains unclear.
4 The most accepted hypothesis has postulated that laughter has two components: the mirth,
5 related with the temporal and frontal neocortical areas, and the motor aspect, related with the
6 limbic system and brainstem. Furthermore, in prior studies, laughter has been elicited during
7 electrical stimulation with depth electrodes in the supplementary motor area and the
8 cingulum.

9 The present video reports a right superior frontal gyrus diffuse astrocytoma (IDH mutant,
10 WHO grade II) resection with awake intraoperative electrical cortical and subcortical
11 stimulation mapping. A DTI-tractography, including all the tracts in relation with the tumor,
12 was obtained pre- and postoperatively. The stimulation of the cingulum located medially and
13 inferiorly to the tumor, elicited a patient's smile and laugh without mirth or merriment.
14 Besides, this point correlated with the reconstructed cingulum in the intraoperatively
15 navigated DTI-tractography.

16 In conclusion, the present findings support the anatomic subdivision of the laughter's
17 mechanism and the role of the cingulum in its motor component. Furthermore, smile and
18 laughter could be useful functional landmarks to identify the cingulum during subcortical
19 mapping. Although it remains unclear if pursuing the resection beyond this point would have
20 caused permanent postoperative deficits, considering laughter's role in social interaction and
21 other emotion-processing functions associated with the cingulum, in the future it could be
22 potentially considered as a functional limit of the resections of intrinsic tumors.

23

24 KEYWORDS

25 Astrocytoma; awake craniotomy; cingulum; intraoperative electrical stimulation; laughter

26

27

28 SHORT TITLE

29 The cingulum and laughter

1 **ABBREVIATIONS**

2 DTI-tractography: Diffusion Tensor Imaging-tractography

3 ROI: region-of-interest

Journal Pre-proof

1 **FUNDING AND DECLARATIONS OF INTEREST**

2

3 **Financial support and industry affiliations:** none. This research did not receive any specific
4 grant from funding agencies in the public, commercial, or not-for-profit sectors.

5

6 **Declarations of interest:** none.

Journal Pre-proof