

Risk of Seizures During Asleep Neurosurgeries Including Intraoperative Neurophysiological Monitoring: a Systematic Review and Meta-analysis

A. Colitta¹, F. Buracchi Torresi¹, C. Bernardini¹, C. Scarpitta¹, D. Hoxhaj¹, G. Siciliano¹, E. Bonanni¹, F. Turco¹.

¹ Department of Clinical and Experimental Medicine, Neurology Unit, University of Pisa, Pisa;

² Neurology Unit, Pisa University Hospital, Pisa

OBJECTIVES

Intraoperative seizures (IOS) during neurosurgeries are associated with **adverse perioperative outcomes**. A systematic estimate of IOS risk during asleep neurosurgery is currently lacking. This study aims to **systematically review and meta-analyze IOS risk during asleep neurosurgery including intraoperative neurophysiological monitoring (IONM)**, and to **assess possible moderators of such risk** in both published literature and our recordings (PROSPERO ID: CRD420251001202).

METHODS

AC and FBT performed study screening and data extraction. Only original studies including > 10 participants were included. A **random-effects model with double arcsine transformation** was fitted to estimate IOS risk. Between-study heterogeneity was assessed through the I^2 index. CB and CS gathered unpublished, retrospective data from Pisa University Hospital.

Meta-regression modelling, subgroup analyses and a sensitivity analysis were performed to explore the contribution of the following moderators to both **pooled IOS risk and between-study heterogeneity**: direct cortical stimulation (DCS), transcranial motor evoked potentials (tMEPs), history of seizures, preoperative antiseizure medications use, preoperative antiseizure prophylaxis, craniotomy, localization and type of space-occupying brain lesions, seizure definition (electrographic/clinical), year of publication, study design (retrospective/prospective), deep brain stimulation (DBS), and pediatric population. A Baujat plot was computed to detect studies potentially increasing between-study heterogeneity.

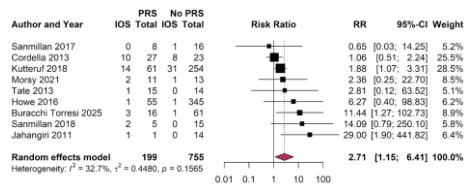
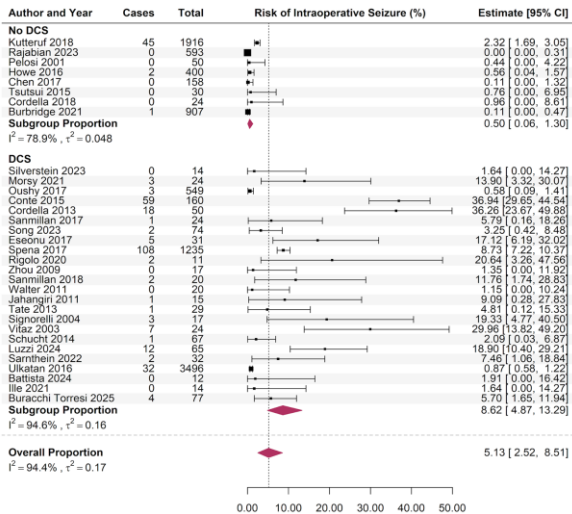
RESULTS

Out of 243 screened studies, 31 were included along with our retrospective cohort.

10155 neurosurgeries, 314 patients experiencing at least one IOS. Pooled IOS risk 5.1% (95%CI=2.52-8.51; $I^2=94.4\%$).

Subgroup analyses showed IOS risk to be significantly higher in studies involving at least one neurosurgery with DCS (8.62%, 95%CI=4.9-13.29; $p<0.001$, $I^2=94.6\%$), compared to studies without DCS (0.5%, CI95%=0.06-1.3; $I^2=78.9\%$). The Baujat plot identified 3 studies involving DCS as major contributors to between-study heterogeneity. Among studies without DCS, tMEPs were not associated with IOS risk variation ($p=0.5$).

In parallel, parietal tumors were associated with a 0.55-fold reduction in IOS risk (RR 95%CI=0.4-0.7; $I^2=0\%$; N studies=2), compared to differently located tumors.



Moreover, history of pre-operative seizures (PRS) was associated with a 2.7-fold increase in overall IOS risk (RR 95%CI=1.1-6.4; $I^2=32.7\%$; N studies=9). The sensitivity analysis excluded that pediatric (N=1) and DBS cohorts (N=2) significantly increased between-study heterogeneity.

The remaining potential moderators did not significantly impact the risk of intraoperative IOS, partially due to paucity of available data.

DISCUSSION

Direct cortical stimulation and history of seizures increase IOS risk during asleep neurosurgeries including IONM, while tMEPs do not. Parietal tumors may be associated reduced IOS risk. Contrarily to awake neurosurgeries, antiseizure medications use and tumor localization do not significantly impact IOS risk. Further prospective studies comprehensively assessing factors associated with IOS during neurosurgeries including IONM are needed.