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Klinik für Neurochirurgie

DGNC

NCAFW

Elektrophysiologisches Monitoring in der spinalen Chirurgie

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RWTH Aachen

Was ist elektrophysiologisches Monitoring?

…und wozu braucht man es?

Wie wird es gemacht?

Wobei wird es eingesetzt?

Ist der Nutzen belegt?

Was und wozu?

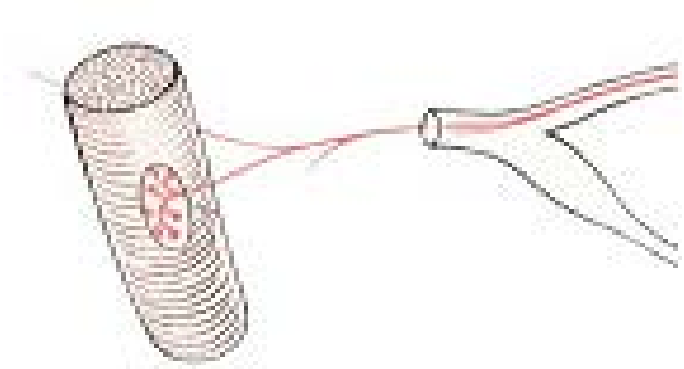
Klinisch-neurophysiologische Methoden als Ersatz der klinischen Untersuchung beim Patienten unter Narkose

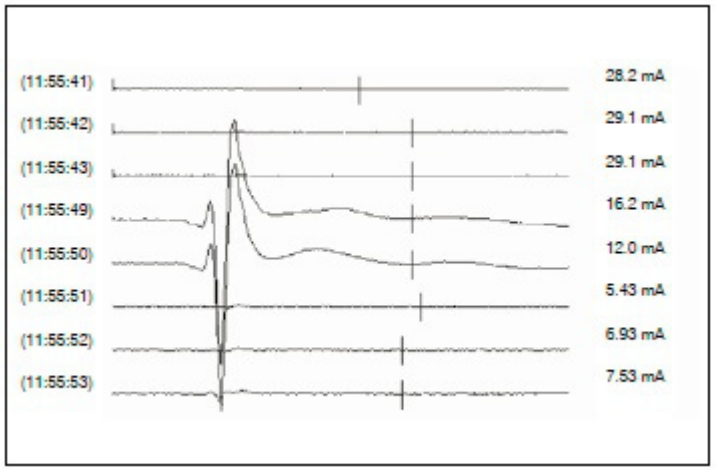
Nervenwurzel-EMG: frei oder stimuliert
Evozierte Potentiale somatosensibel
Evozierte Potentiale motorisch

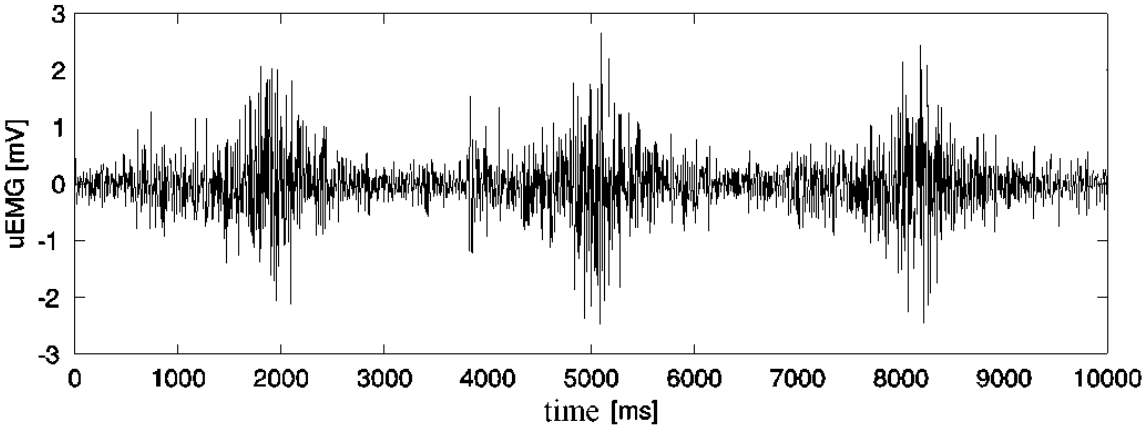
Mapping: Indentifikation neuronaler Strukturen
Monitoring: Kontinuierliches funktionelles Feedback

Prognose
Warn-/Entwarnungsfunktion
Lernkurve

„Nervenwurzel-EMG“







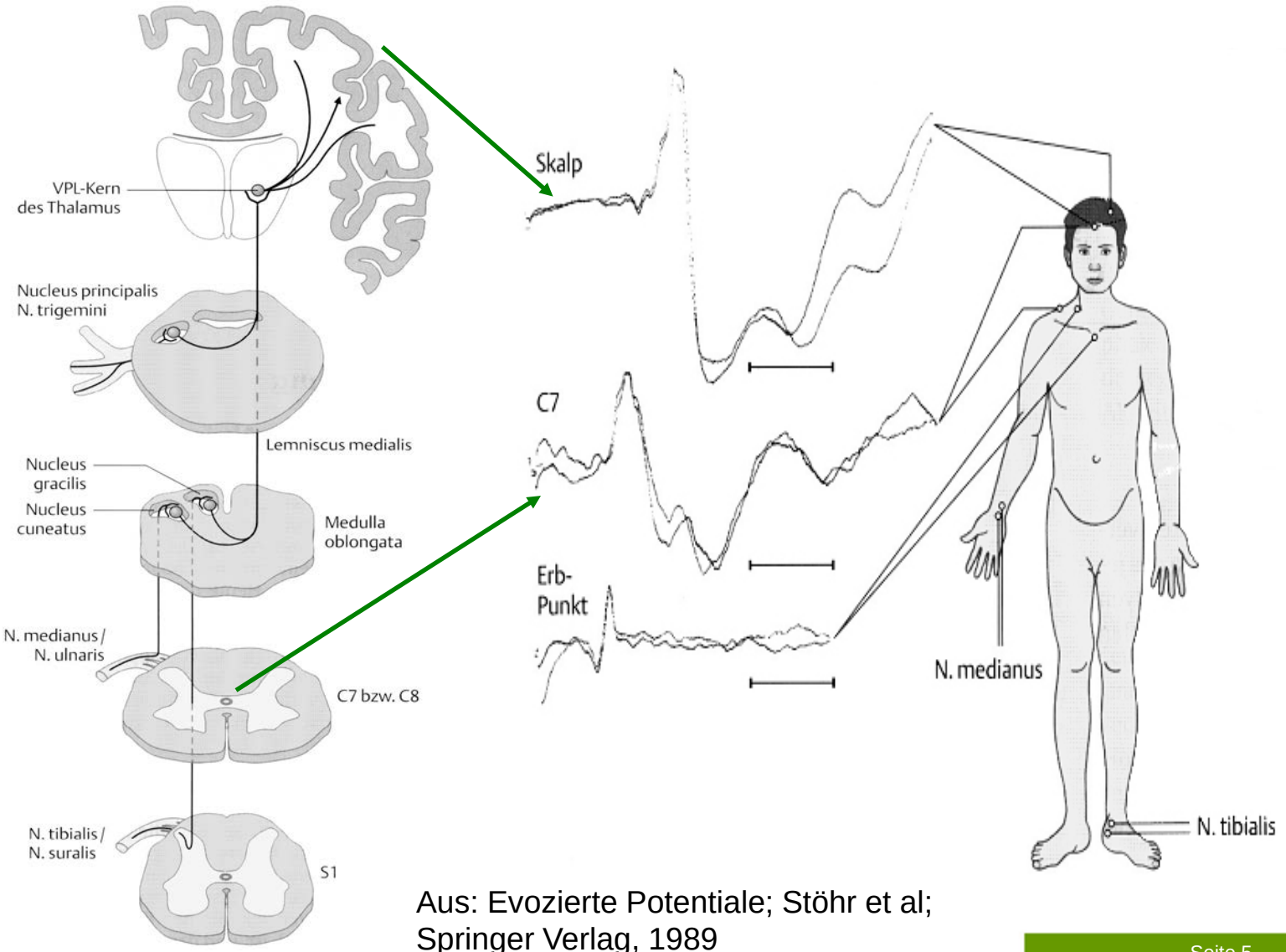
Somatosensibel Evoziertes Potential

Kortikal

Hirnstamm

Spinal Hinterstrang

peripher



Aus: Evozierte Potentiale; Stöhr et al; Springer Verlag, 1989

Motorisch Evoziertes Potential

ELSEVIER

Clinical Neurophysiology 112 (2001) 445–452

Neurophysiological mechanisms underlying motor evoked potentials in anesthetized humans.
Part 2. Relationship between epidurally and muscle recorded MEPs in man

Vedran Deletis[a,*], Zoran Rodi[b], Vahe E. Amassian[c]

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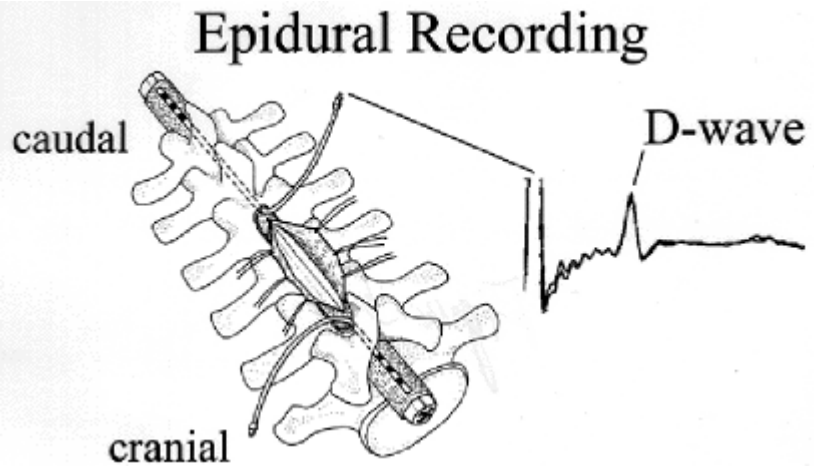
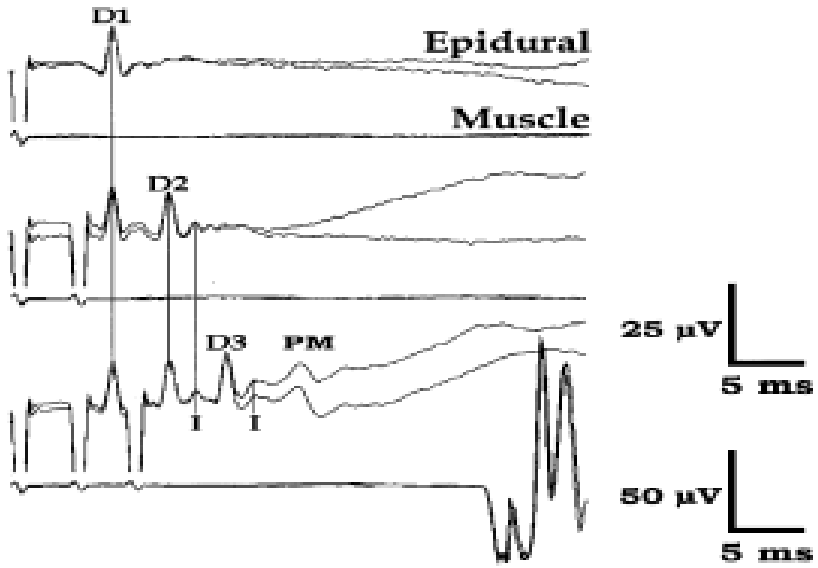
[b]*University Institute of Clinical Neurophysiology, School of Medicine, University of Ljubljana, Ljubljana, Slovenia*
[c]*Departments of Physiology and Neurology, Health Science Center at Brooklyn, State University of New York, Brooklyn, NY, USA*





Motorisch evozierte Potentiale in Narkose – spinales Monitoring

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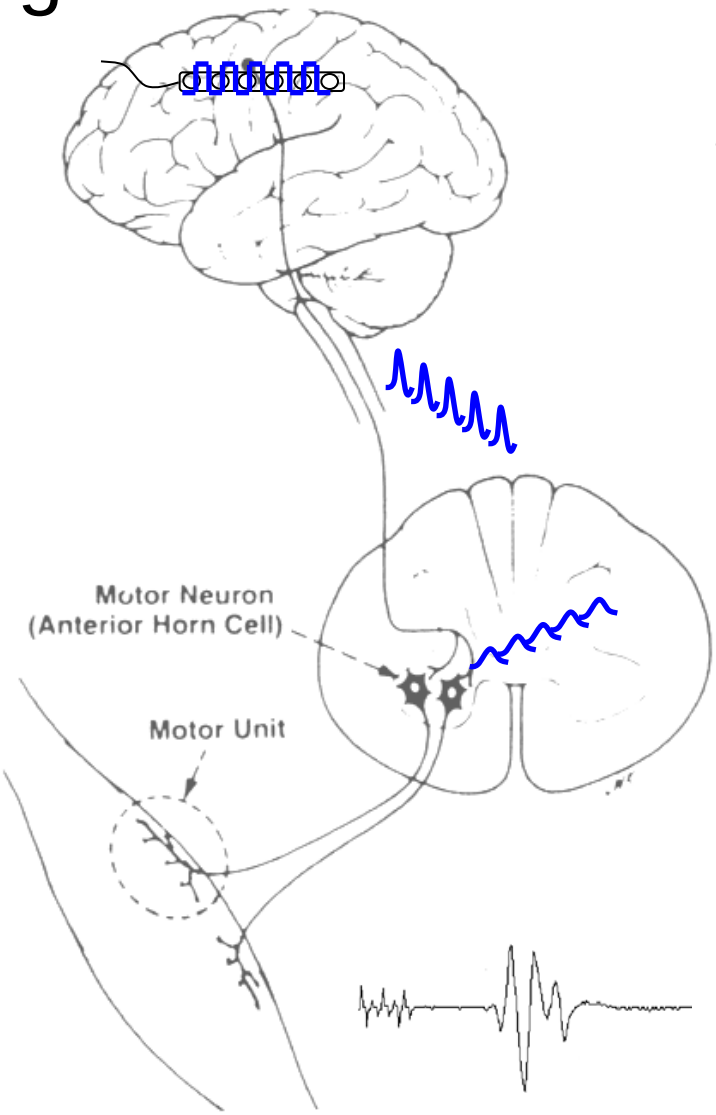
Messung alle 0,5-10 s (…)

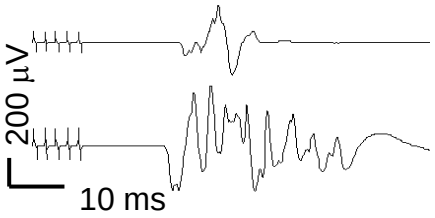
- transkranielle Motorkortex-(M1-)Stimulation
- hochfrequente „train“-Stimulation:
  5-7 anodale Konstantstrom-Pulse (<30 mA)
  von 0.3-1 ms bei 250-500 Hz
- Summation von EPSPs am α–MN
- SAP von distaler Extremitätenmuskulatur (MEP)
  differentielle Ableitung, ungemittelt, 0-3kHz BP

- Alles-oder nichts (statt Amplitudenkriterium)



Anästhesie-/Narkoseregimen:

- TIVA mit Propofol
- Isofluran <1 mac + Opioid (Remifentanil)
- keine (partielle, TOF 2/4) Muskelrelaxation



Konstanter Strom

konstante Spannung

mMEP – supportives spinales System

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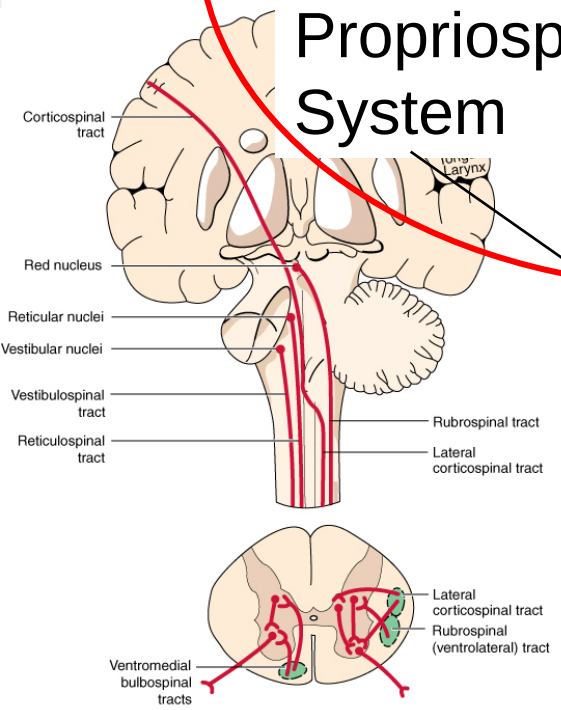
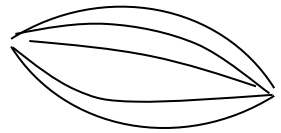
CST

„Bulbo-Spinales System“

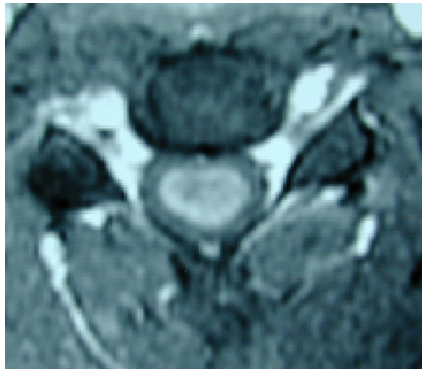
Propriospinales System



α-MN



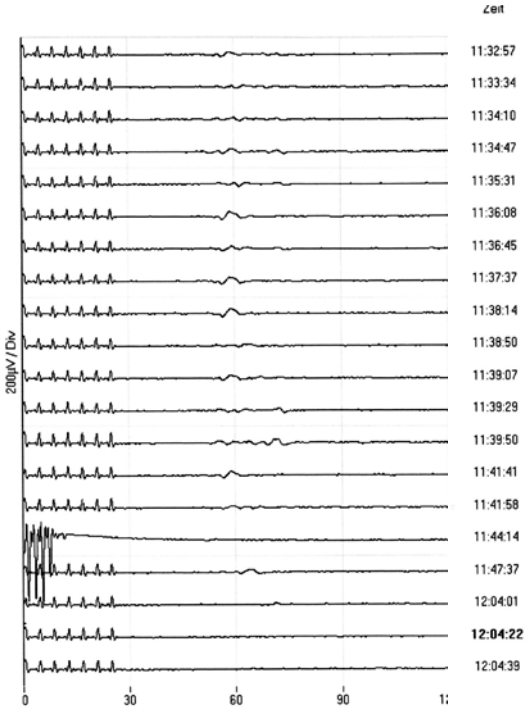
Source: Fauci AS, Kasper DL, Braunwald E, Hauser SL, Longo DL, Jameson JL, Loscalzo J: *Harrison's Principles of Internal Medicine*, 17th Edition: http://www.accessmedicine.com



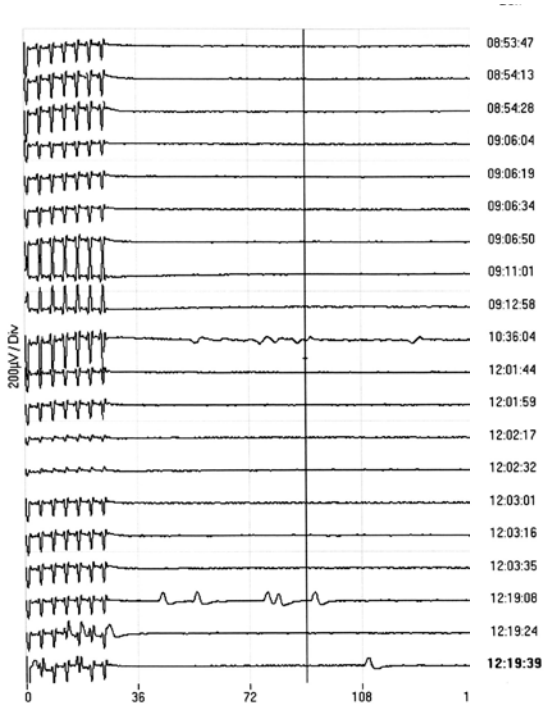
Ependymom BWK 3

A. Szelényi
B. Düsseldorf

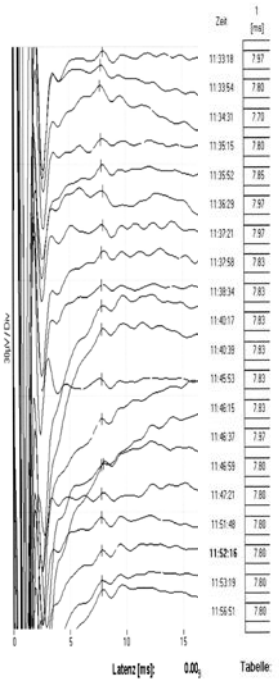
mMEPs R: Verlust



mMEPs L: keine Antwort



D-Welle BWK 5: stabil

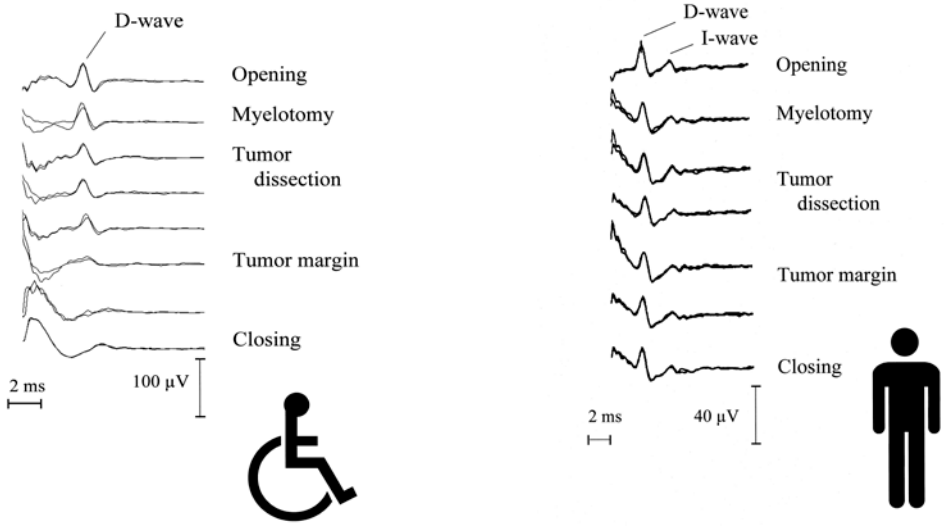


postoperativ transiente Zunahme der Paraparese

TABLE 2

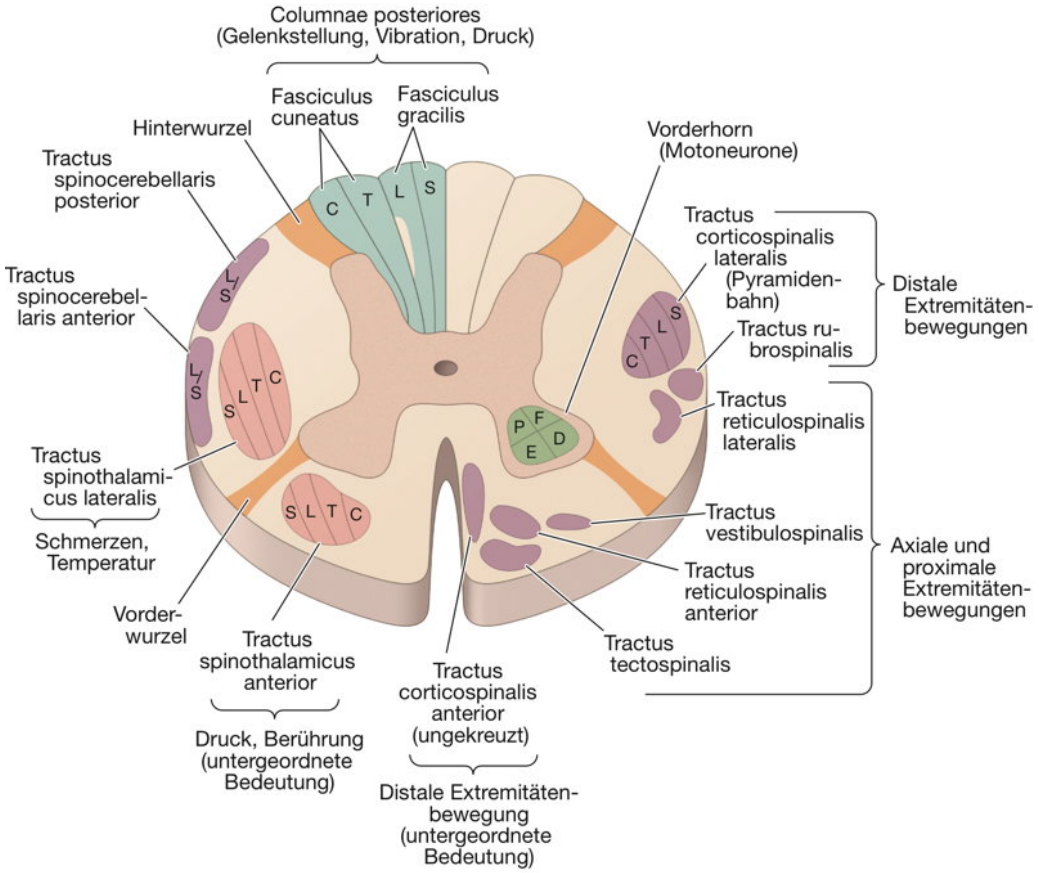
PRINCIPLES OF COMBINED MEP DATA INTERPRETATION

D-wave	Muscle MEP	Postop Motor Status
unchanged	preserved	unchanged
unchanged	lost uni- or bilat	temporary motor deficit
30–50% decrease	preserved	unchanged
30–50% decrease	lost uni- or bilat	temporary motor deficit
>-50% decrease	lost bilat	long-term motor deficit

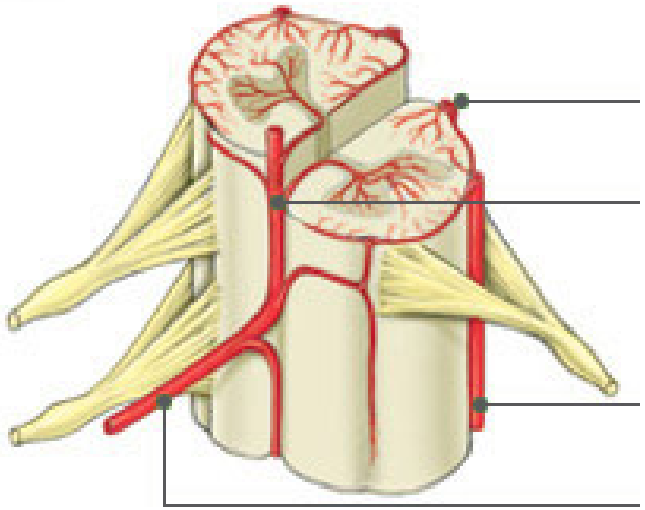


Karl Kothbauer, M.D., Vedran Deletis M.D.Ph.D., Fred Epstein: Motor Evoked Potential monitoring for intramedullary spinal cord tumor surgery: Correlation of clinical and neurophysiological data in a series of 100 consecutive procedures. Neurosurg. Focus 4:Art 1 1998

Wo wird es eingesetzt?



Aus: Harrisons Innere Medizin, 18. Auflage (Copyright: ABW Wissenschaftsverlag GmbH)



Aus: Harms-Spinesurgery.com

EP bei intramedullären und ev. bei
sonstigen intraduralen Eingriffen. Motorik: MEP

EP bei ventraler/dorsaler Instrumentierung,
Fusion und Dekompression bei degenerativen Prozessen

EP bei WS-Korrekturen (Trauma, Skoliose)

EP bei Lagerung der HWS und cervikaler Stenose)

EMG bei (endoskopischen) Bandscheibenvorfällen
und Foraminalstenosen

EMG bei lateralen Zugängen zu LWS

EMG oder Impedanzmessung bei Pedikelschrauben

EMG (EP) bei dysraphischen Störungen

Pudendus-SEP, BCR

Ist der Nutzen belegt?

Evidence-Based Guideline Update: Intraoperative Spinal Monitoring with Somatosensory and Transcranial Electrical Motor Evoked Potentials*

Marc R. Nuwer, Ronald G. Emerson,† Gloria Galloway,‡ Alan D. Legatt,§ Jaime Lopez,‖ Robert Minahan,¶ Thoru Yamada,# Douglas S. Goodin,** Carmel Armon,†† Vinay [illegible] thia L. Harden‖‖*

(*J Clin Neurophysiol* 2012;29: 101–108)

4 Studien Evidenz-Klasse I, 8 Studien Evidenz-Klasse II (Kriterien für diagnostische Studien)

CONCLUSION

IOM is established as effective to predict an increased risk of the adverse outcomes of paraparesis, paraplegia, and quadriplegia in spinal surgery (four class I and seven class II studies).

RECOMMENDATION

Surgeons and other members of the operating team should be alerted to the increased risk of severe adverse neurologic outcomes in patients with important IOM changes (level A).

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Giorgio Palandri, M.D.
Section of Neurosurgery, Department of Neurological

Motor Evoked Potential Monitoring Improves Outcome after Surgery for Intramedullary Spinal Cord Tumors: A Historical Control Study

Sala et al., Neurosurgery, 2006

Historische Kontrollgruppe, vergleichbar u.a. bzgl. Resektionsausmaß

TABLE 7. Comparison between postoperative mean variation of McCormick grade at discharge and at follow-up for ependymomas and astrocytomas[a]

	Mean variation in McCormick grade at discharge		Mean variation in McCormick Grade at follow-up		
	Astrocytomas (n = 22)	Ependymomas (n = 49)	Astrocytomas (n = 22)	Ependymomas (n = 49)	Student's *t* test
INM group discharge	−0.18 (n = 11)	−0.25 (n = 24)			$P = 0.8022$
INM group follow-up			+0.18 (n = 11)	+0.37 (n = 24)	$P = 0.3703$
HC group discharge	−0.45 (n = 11)	−0.76 (n = 25)			$P = 0.3149$
HC group follow-up			0 (n = 11)	−0.48 (n = 25)	$P = 0.0211$
Student's *t* test	$P = 0.3848$	$P = 0.0331$	$P = 0.4313$	$P < 0.0001$	

[a] INM, intraoperative neurophysiological monitoring; HC, historical control. The comparison was performed within the INM and HC groups and between them. By study choice, preoperative Grade distribution and rate of removal were similar in the two groups (*Table 2*).

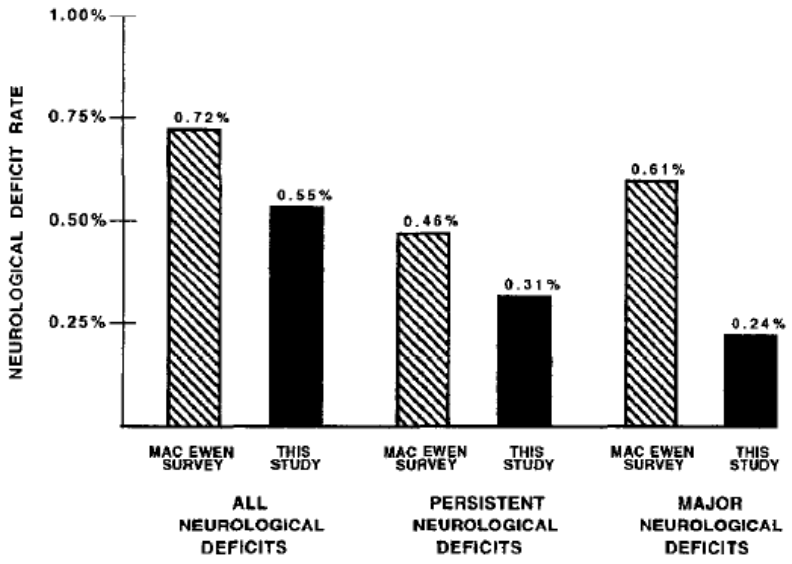
Somatosensory evoked potential spinal cord monitoring reduces neurologic deficits after scoliosis surgery: results of a large multicenter survey

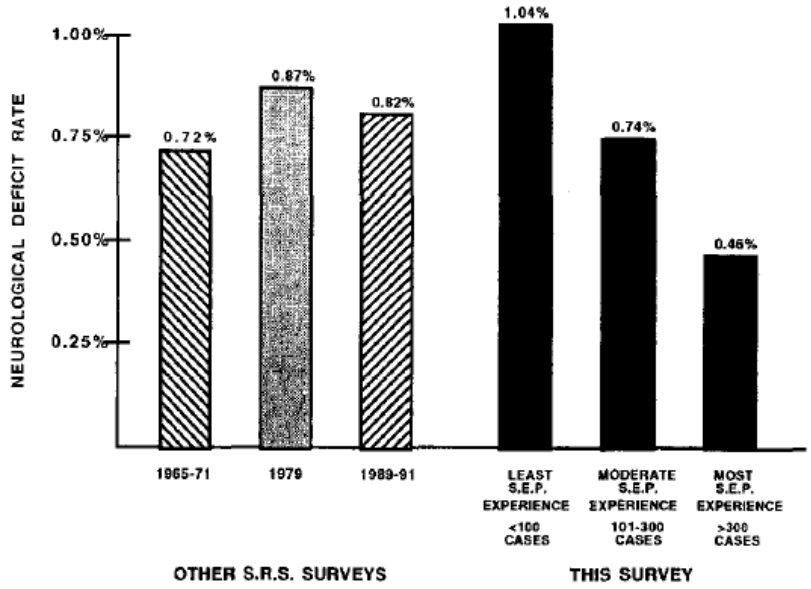
Marc R. Nuwer [a,b,*], Edgar G. Dawson [c], Linda G. Carlson [b], Linda E.A. Kanim [c] and John E. Sherman [c,d]

[a] *UCLA Department of Neurology, 710 Westwood Plaza, Room 1-194, Los Angeles, CA 90024-6987 (USA),* [b] *UCLA Department of Clinical Neurophysiology and* [c] *UCLA Department of Orthopedic Surgery, Los Angeles, CA 90024 (USA), and* [d] *Edina, MN (USA)*

Electroencephalography and clinical Neurophysiology 96 (1995) 6–11

53.000 Skoliosekorrekturen (von 97.000) mit SEPs, historische Vergleichsgruppe





Does intraoperative neurophysiologic monitoring matter in noncomplex spine surgeries?

OPEN

John P. Ney, MD, MPH
David N. van der Goes, PhD
Marc R. Nuwer, MD, PhD

Neurology® 2015;85:1–8

1,1 Mio Entlassungen 2007-2012
einfache Fusionen oder Dekompressionen
Nur Ersteingriffe

4,9% IONM

Table 3 Sample-weighted clinical and nonclinical outcomes by IOM status

	Neurologic complications, %	Total hospitalization charges	Length of stay, d
No IOM	1.4	$45,266	3.0
IOM	0.8	$62,999	3.0

Table 4 Bivariate and multiple regression–adjusted sample-weighted associations of IOM with neurologic complications, percentage of total hospital charges, and length of stay (marginal effect, in days)

	Neurologic complications, logistic regression	Total hospital charges, GLM, log-transformed	Length of stay, Poisson, marginal effect
Bivariate			
β_{IOM}	OR 0.56	+39%	dy/dx = −0.02 days
95% CI	0.44, 0.72	31%, 48%	−0.19, +0.16
p Value	<0.001	<0.001	0.86
Multiple regression			
β_{IOM}	OR 0.60	+9%	dy/dx = −0.26 days
95% CI	0.47, 0.76	4%, 13%	−0.42, −0.11
p Value	<0.001	<0.001	<0.001

Abbreviations: βIOM = coefficient representing effect of IOM and marginal effect (dy/dx) of IOM on days of length of stay; CI = confidence interval; GLM = generalized linear model; IOM = intraoperative neurophysiologic monitoring; OR = odds ratio.

Intraoperative Elektrophysiologie :

- funktionellen Identifikation
- Überwachung und Prognose
- Lerneffekt

Methoden: Evozierte Potentiale (Motorik: MEP, D-Welle) und (stimuliertes) EMG

Einsatz unterliegt bisher lokalen/persönlichen Präferenzen

Starke Evidenz (Stufe I b) für Validität als Diagnostikum

Evidenz Stufe IIb, dass intraoperatives neurophysiologisches Monitoring das neurologische Outcome bei intramedullären und vielen Wirbelsäulen-Eingriffen verbessert