

Endovaskulární léčba

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Liberec 24.4.2024



Souhrn

- Stručná doporučení EVT
- „okrajové“ situace pro EVT
- Failed MT
- Spinální ischemie

EVT

onset

6:00h 7:18h



NCCT

ICA, M1
M2

„bridging“ IVT

MT alone

„drip-and-ship“

„mothership“

sedace

celková anestezie

eCAS

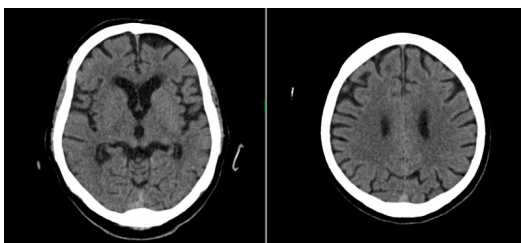
MT alone

prehosp triage LAO

primární transfer

IVT nesmí zpozdit transport do KCC

4,5h

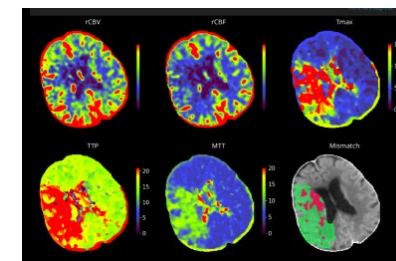


onset

6,0h

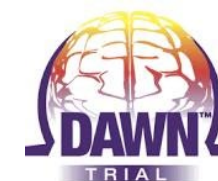


16/24h



refuse

≤ 90	≤ 80	age	< 80		≥ 80
≥ 6	<70 >15 >1,8	NIHSS	≥ 10	≥ 20	≥ 10
		core [ml]	≤ 30	31-51	≤ 20
		penumbra [ml]			
		penumbra/core vol			
≤ 2		mRS	≤ 1		
≥ 6		life expectancy	≥ 6		
M1		occlusion	M1		
ICA			ICA		
eICA					



EVT- kontraindikace

absolutní

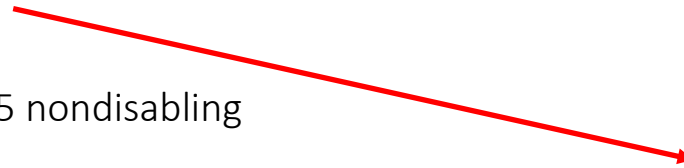
alergie - Ni, Ti
life expectancy < 3M

relativní

alergie - KL
gravidita
mRS > 3
NIHSS < 5 nondisabling
MeVO
distal occlusion

není KI

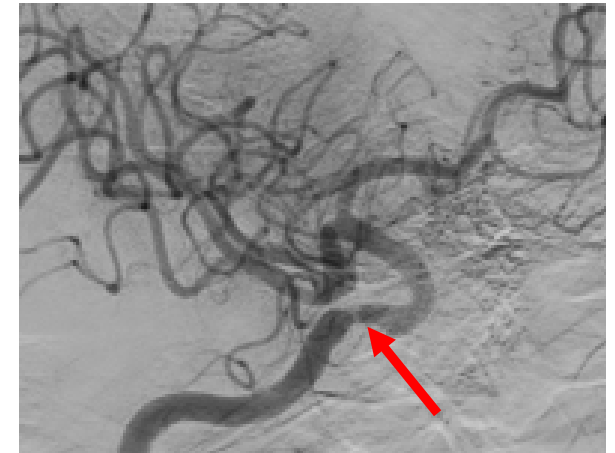
věk
NIHSS > 25
VKA, NOAC
trombocytopenie



Časná reokluze po MT

Časná reokluze LVO

reocclusion rate	3-9%	(2,3%-29,5%)
timing	12-48h	
symptomatické	71%	



APT
statin
FiS
M1

poškození endotelu
agregace destiček
tkáňový faktor
zánět



OTT
ateroskleróza (in situ trombóza)

multiple pass (stent + aspirace)
komplikovaná rekanalizace
reziduální fragmenty, stenóza po iMT

Reokluze:

časná deteriorace

klinický outcome

4-7x horší

mRS 0-2 (20% vs > 50%)

mortalita

2x vyšší

Prevence:

- wait and check (spasmus vs reziduální stenóza)
windowing
projekce
- monitorace TCD

rMT

účinnost (TICI \geq 2b) 50%

bezpečnost (sICH) 7%

discharge *mRS 0-2* 30%



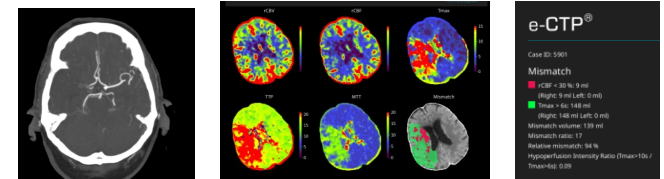
Ischemie
„low ASPECTS“
„late presentation“

ASPECTS ≤ 5 , large stroke

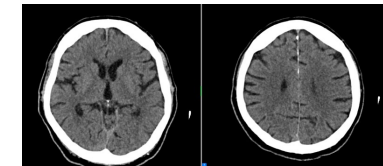
Trials:
ANGEL-ASPECT:
SELECT2:
RESCUE-Japan LIMIT

TENSION

LASTE (protocol):



ASPECTS 3-5
advanced imaging (CTA, CTP, MRI)



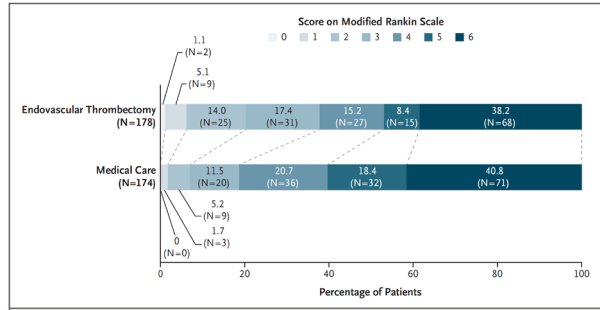
ASPECTS < 5
NCCT, DWI

ASPECTS ≤ 5 , < 7h

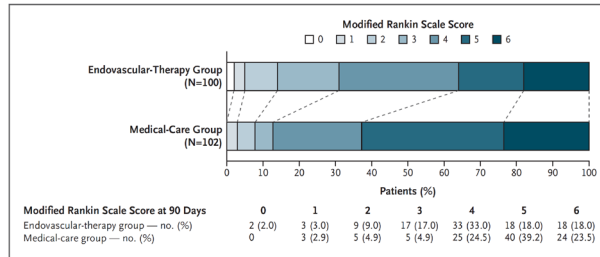
Sarraj A et al. N Engl J Med. 2023 Apr 6;388(14):1259-1271.
Huo X et al. N Engl J Med. 2023 Apr 6;388(14):1272-1283.
Bendszus M et al. Lancet. 2023 Nov 11;402(10414):1753-1763.
Yoshimura S et al. N Engl J Med. 2022 Apr 7;386(14):1303-1313.



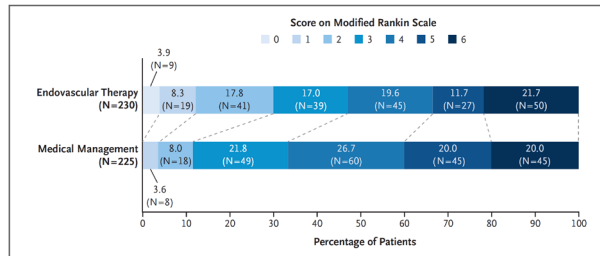
SELECT2



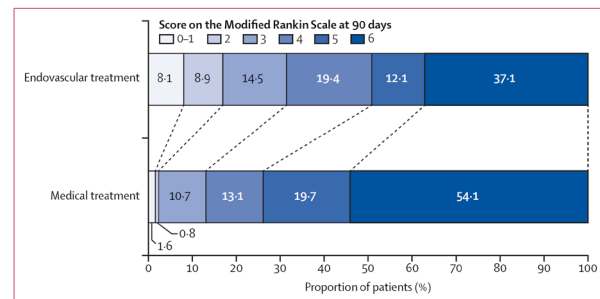
RESCUE-Japan LIMIT



ANGEL-ASPECT



TENSION



EVT+BMM

mRS ≤ 2: 14-30%
17%

mRS ≤ 3: 31-47%
31%

Death: 18-38,4%
40%

BMM

mRS ≤ 2: 7,0-11,6%
2%

mRS ≤ 3: 12,7-33,3%
13%

Death: 20,0-41,5%
51%

ICH, sICH - NS

ASPECTS < 5	20-27% LAO
IVT	20%
NNT	5

Absolutní rozdíl:

- schopnost chůze: + 18%
- Pokles mortality: - 11%

IVT

min	mRS 0-1
0-90	NNT 4,5
90-180	NNT 9
180-270	NNT 14



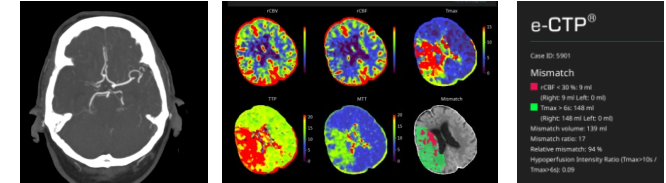
Late presentation LAO - EVT - doporučení/GDL

Stroke: Vascular and Interventional Neurology

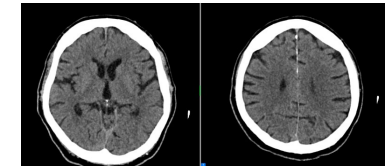
GUIDELINE

Mechanical Thrombectomy in the Late Presentation of Anterior Circulation Large Vessel Occlusion Stroke: A Guideline From the Society of Vascular and Interventional Neurology Guidelines and Practice Standards Committee

Thanh N. Nguyen, MD[†]; Alicia C. Castonguay, PhD[†]; James E. Siegler, MD; Simon Nagel, MD; Maarten G. Lansberg, MD, PhD; Adam de Havenon, MD, MSCI; Sunil A. Sheth, MD; Mohamad Abdalkader, MD; Jenny P. Tsai, MD; Gregory W. Albers, MD; Hesham E. Masoud, MD; Tudor G. Jovin, MD; Sheila O. Martins, MD, PhD; Raul G. Nogueira, MD; Osama O. Zaidat, MD, MS; for the SVIN GAPS Committee



In patients with proximal anterior circulation LVO 6 to 24 h from last known well, NCCT can be used as the sole imaging modality to evaluate infarct size, particularly when access to CTP or MRI is limited or if their performance would incur substantial delay to treatment. (COR-2a; LOE B-NR)



NCCT
Drip-'n'-ship

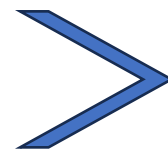
- možné místo CTP
- DIDO < 15 min

In patients with a suspected LVO presenting within the 6 to 24 h of last known well, it may be reasonable to transport the patient directly to an EVT-performing center if transport time would not be delayed by > 15 min relative to the nearest stroke center. (COR-2b; LOE EO-C)

mRS ≤ 4

> 80 let

LSN 6-24h (known/UOS/WUS)



EVT reasonable / recommended



Failed MT

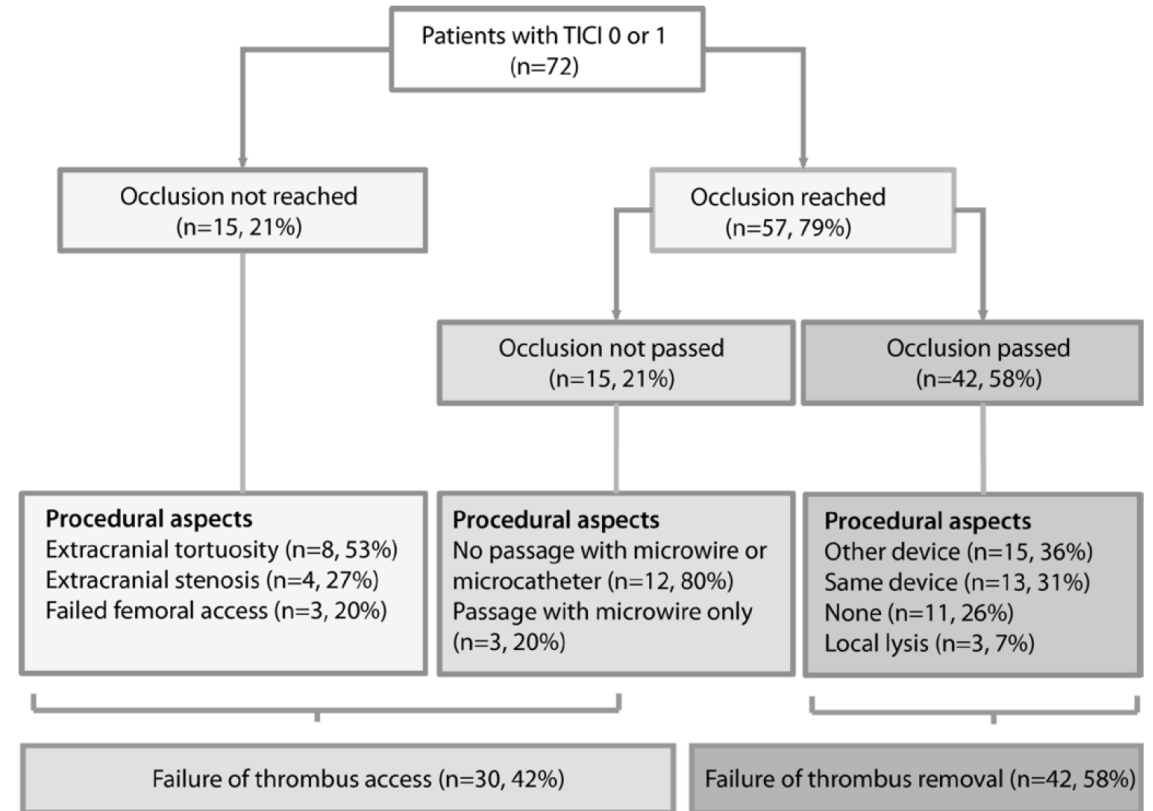
Intrakraniální mikrochirurgická rekanalizace

MT neúspěšná: 11-29%

Persistující LAO: 30-35% trvalá invalidita/ smrt

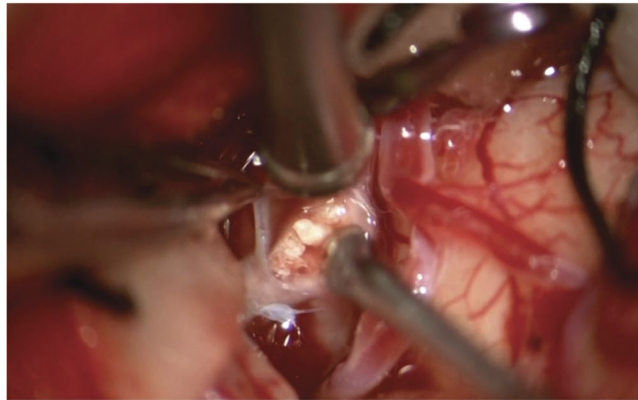
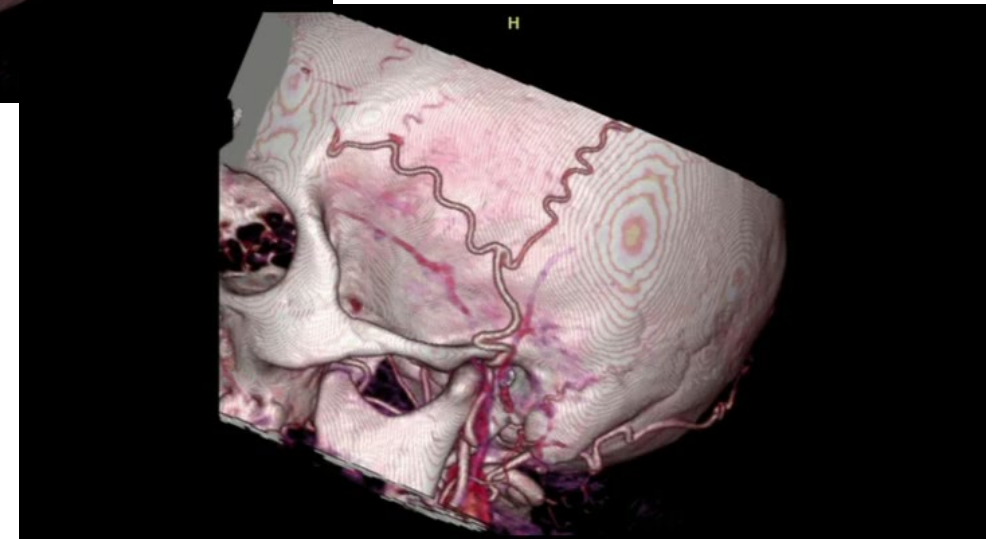
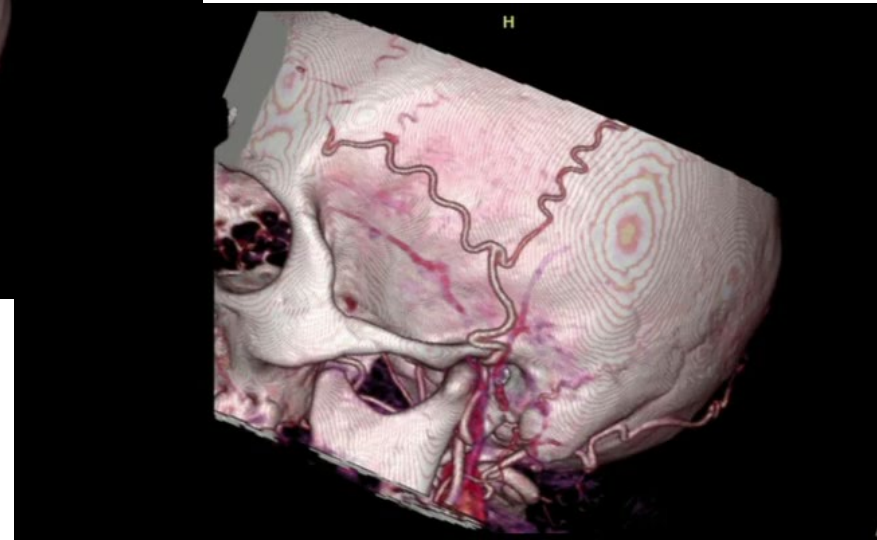
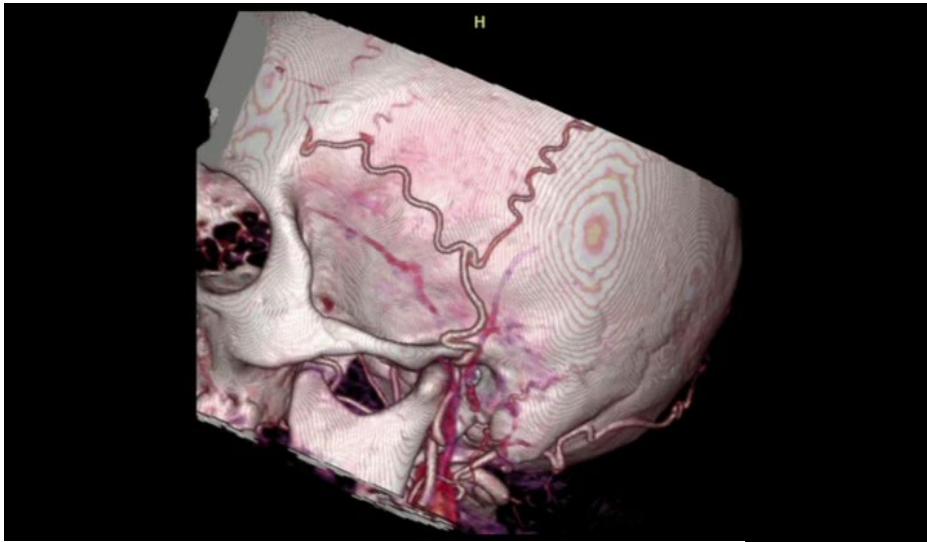
Možnosti řešení:

- ponechat bez nerekanalizace
- mikrochirurgie
 - EC-IC
 - embolektomie



Urgent Middle Cerebral Artery Embolectomy of Calcified Embolus After Intravenous Thrombolysis: 2-Dimensional Operative Video

Jiri Fiedler, MD, PhD^{*†}, Svatopluk Ostry, MD, PhD^{§¶},
Martin Bombic, MD^{*}, Ludek Sterba, MD^{||}, Petr Kostal, MD^{*‡}






https://journals.lww.com/ononline/fulltext/2019/08000/urgent_middle_cerebral_artery_embolectomy_of.23.aspx

Etiologie:
embolizace při AAA
ateroskleróza

Original research

Emergent microsurgical intervention for acute stroke after mechanical thrombectomy failure: a prospective study

Jiří Fiedler ,^{1,2} Martin Roubec ,^{3,4} Marek Grubhoffer,^{1,2} Svatopluk Ostrý ,^{5,6}
Václav Procházka ,⁷ Kateřina Langová,⁸ David Školoudík ,^{4,7} for the EMIAS Study Group

2 centra

47 pacientů

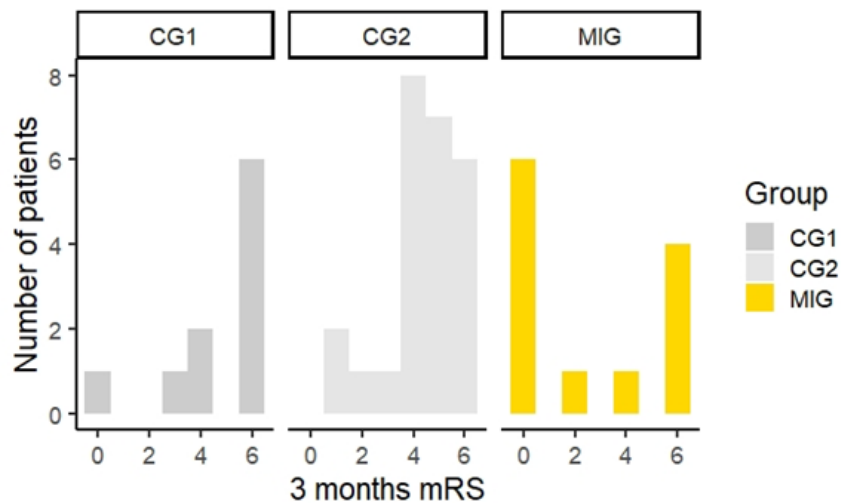
3 skupiny: C-1: mikrochirurgie (embo, ECIC)
 kontrolní - 1
 C-2: kontrolní - 2

Mikrochirurgie:

IVT: 58,4%
OTF: 404 ± 101 min
TICI 2b-3: 75%



EMIAS



	MSIG (n=12)	CG1 (n=10)	P value	CG2 (n=25)	P value
NIHSS score at admission; median (IQR)	14.0 (5-22)	15.5 (5-24)	0.888*	16.0 (4-22)	0.757*
NIHSS score after 24 hours; median (IQR)	7.0 (0-21)	16.0 (2-23)	0.241*	14.0 (3-25)	0.158*
NIHSS at day 7 (alive only); median (IQR)	3.0 (0-19)	13 (2-19)	0.502*	14 (2-35)	0.110*
mRS score 0-2 prior to stroke; n (%)	12 (100.0)	9 (90.0)	0.910†	25 (100.0)	1.000
mRS score 3 prior to stroke; n (%)	0 (0.0)	1 (10.0)	0.910†	0 (0.0)	1.000
mRS score 0-1 at day 90; n (%)	6 (50.0)	1 (10.0)	0.148†	2 (8.0)	0.016†
mRS score 0-2 at day 90; n (%)	7 (58.3)	1 (10.0)	0.062†	3 (12.0)	0.012†
mRS score 0-3 at day 90; n (%)	7 (58.3)	2 (20.0)	0.198†	4 (16.0)	0.036†
mRS score 4-5 at day 90; n (%)	1 (8.3)	2 (20.0)	0.667†	15 (60.0)	0.003†
Death within 7 days; n (%)	0 (0.0)	3 (30.0)	0.156†	0 (0.0)	1.000
Death within 90 days; n (%)	4 (33.3)	6 (60.0)	0.782†	6 (24.0)	1.000†
Cerebral edema; n (%)	0 (0.0)	3 (30.0)	0.156†	4 (16.0)	0.564†
Decompressive craniectomy; n (%)	0 (0.0)	0 (0.0)	1.000†	1 (4.0)	1.000†
sICH; n (%)	0 (0.0)	0 (0.0)	1.000†	1 (4.0)	1.000†

mRS 0-2: 58,3% vs 10% OR 12,6 p= 0,062
 58,3% vs 12% OR 10,27 p= 0,012

mRS 6
sICH: NS

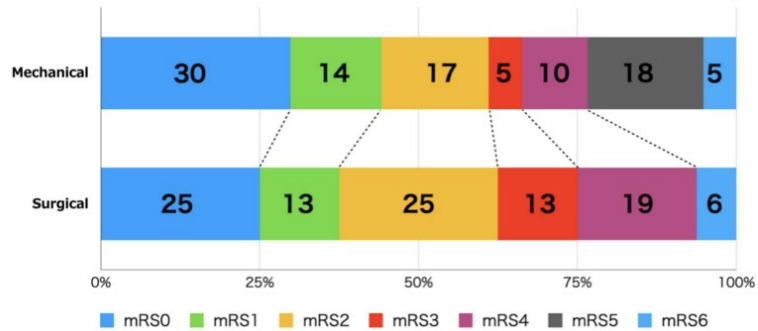
Mikrochirurgická rekanalizace - rekanalizační léčba „3rd line“.



Microsurgical thrombectomy: where the ancient art meets the new era

Nakao Ota¹ · Arnau Benet^{1,2} · Muhammad Kusdiansah^{1,3} · Norio Miyoshi¹ · Kenichi Haraguchi¹ · Kosumo Noda¹ · Michael T. Lawton² · Rokuya Tanikawa¹

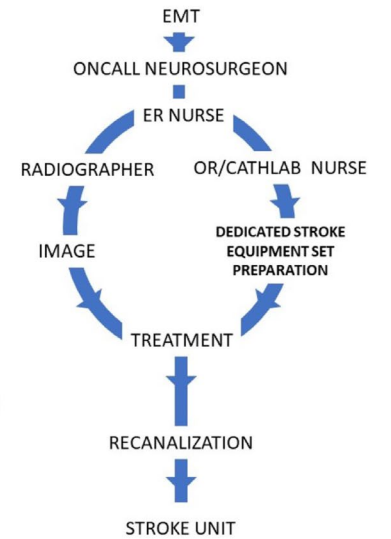
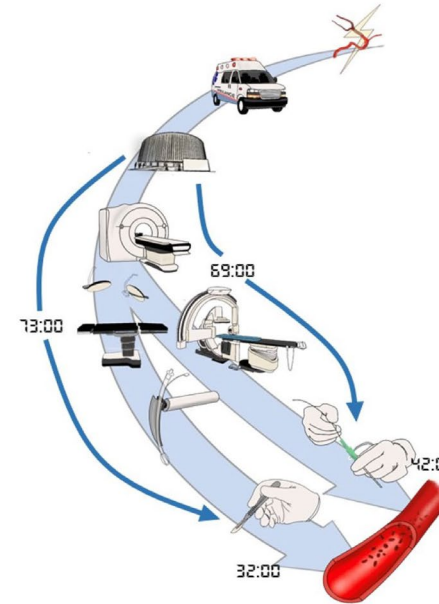
EMIAS - vzorem k „alternativě“ rekanalizace LVO.



Integrace nemocniční logistiky

Chirurgická embolektomie

- non-inferior k MT.
- feasible jako 1st-line rekanalizace LVO



eICA okluze

CAS

CEA

eCAS

TO 10-15% LVO

eCAS antitrombotická terapie

CAA krvácení, restenozá/reokluze

uCEA chirurgické komplikace

Antegrádní vs retrográdní technika?

Akutní in-stent reokluze 1,2-21%

3.13. Emergency Carotid Endarterectomy Carotid Angioplasty and Stenting Without Intracranial Clot

3.13. Emergency Carotid Endarterectomy/Carotid Angioplasty and Stenting Without Intracranial Clot	COR	LOE	New, Revised, or Unchanged
1. The usefulness of emergent or urgent carotid endarterectomy (CEA)/carotid angioplasty and stenting when clinical indicators or brain imaging suggests a small infarct core with large territory at risk (eg, penumbra), compromised by inadequate flow from a critical carotid stenosis or occlusion, or in the case of acute neurological deficit after CEA, in which acute thrombosis of the surgical site is suspected, is not well established.	I Ib	B-NR	Recommendation reworded for clarity from 2013 AIS Guidelines. COR unchanged. LOE amended to conform with the ACC/AHA 2015 Recommendation Classification System. See Table XCV in online Data Supplement 1 for original wording.
2. In patients with unstable neurological status (eg, stroke-in-evolution), the efficacy of emergency or urgent CEA /carotid angioplasty and stenting is not well established.	I Ib	B-NR	Recommendation reworded for clarity from 2013 AIS Guidelines. COR unchanged. LOE amended to conform with the ACC/AHA 2015 Recommendation Classification System. See Table XCV in online Data Supplement 1 for original wording.

Expert opinion on carotid artery stenting in mechanical thrombectomy patients with high-grade cervical stenosis or occlusion

9/11 experts suggest that if inclusion in a dedicated randomized controlled trial is not possible, patients with high-grade stenosis or occlusion may be treated with intraprocedural stenting if unavoidably needed.



eCAS vs aCAA

		eCAS	eCAA
mRS 0-2 restenoza		56,3%	44%
		2%	9%
eCAS:	≈ 2x vyšší rekanalizace ≈ 2x vyšší sICH →	APT+GPI: 11% APT: 7%	eCAA: 7-day stroke risk 10%

IVT bez vlivu na outcome
 bez vlivu na rizika rekanalizace

Retro vs Ante
 ↑ Rekanalizace
 → Funkční outcome



protidestičková léčba
krvácení

Po IVT

ASA < 90min

mRS 0-2 57,2% 54,0%

sICH 4,3% 1,6% Δ 2,8%

Prestroke ASA sICH +1,4%

eCAS



„in-stent“ trombóza
ischemie

elektivní 0,36-2,1%
akutní 5,6-33%
emergentní 28,3%

timing 1,5h
symptomatická 58,3%
příčina adekvátní APT

eCAS - periprocedurální terapie

ASA 250 mg i.v.

CPG 300 mg via NGS

Heparin 5000 IU bolus i.v., kont. 24 h

	ASA+CPG	ASA	ASA+Heparin		P value	Missing data/n (%)	GPI
	Aggressive strategy (n=61)	Aspirin (n=62)	Aspirin+heparin (n=38)	All patients (n=161)			
Stent thrombosis at day 1	2 (3.5)	10 (17.9)	5 (13.9)	17 (11.4)	0.049	12/161 (7.45)	62,5%
mRS 0–2 at 90 days	34 (57.6)	25 (49.0)	21 (55.3)	80 (54.1)	0.655	13/161 (8.07)	37,5%
Mortality at 90 days	9 (15.3)	8 (15.7)	6 (15.8)	23 (15.5)	0.997	13/161 (8.07)	37,5%
Any ICH	21 (35.0)	31 (52.5)	14 (36.8)	66 (42.0)	0.116	4/161 (2.48)	62,5%
Parenchymal hematoma	10 (16.6)	8 (13.6)	5 (13.2)	23 (14.6)	0.836	4/161 (2.48)	25,0%
Symptomatic ICH	3 (5.0)	3 (5.0)	3 (7.9)	9 (5.7)	0.798	3/161 (1.86)	25,0%

ASA 250 mg i.v.
NCCT 2-6h
CPG 300mg p.o./NGS

cangrelol



2 min

clopidogrel

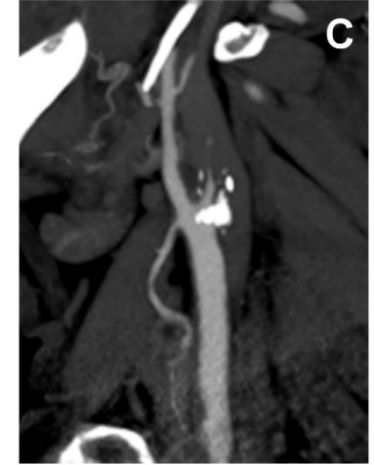


onset

2 hrs



Akutní okluze eICA



	rekanalizace	klinický outcome		sICH
		mRS 0-2	mortalita	
Paciaroni M (2014)	bez rekanalizace	20.6%	15.4%	11.1%
Bhatia R (2010)	IVT	24.9%	27.3%	4.9%
Mokin M (2012)				
Beneš V (2020)	CEA	62%	5%	4%

Urgentní CEA (0-24h):

Nepříznivý outcome (mRS 3-6)

17-42%

Příčiny nepříznivého výsledku:

1) Primární stroke

- dokončená ischemie před CEA

2) Intraoperační ischemie

- prohloubení hypoperfúze uzávěrem kolaterály během cross-clamp

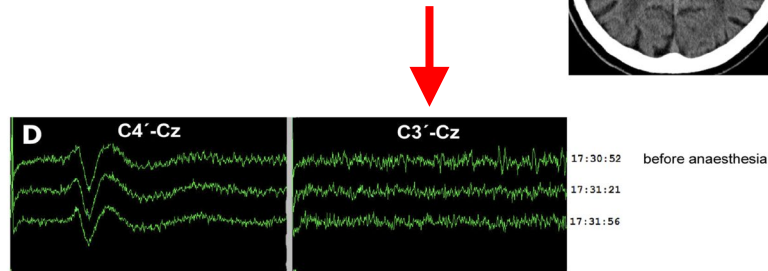
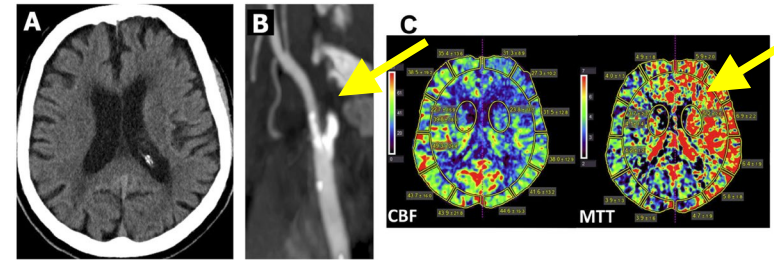


Median somatosensory evoked potential as a predictor of clinical outcome after urgent surgical extracranial internal carotid artery recanalization

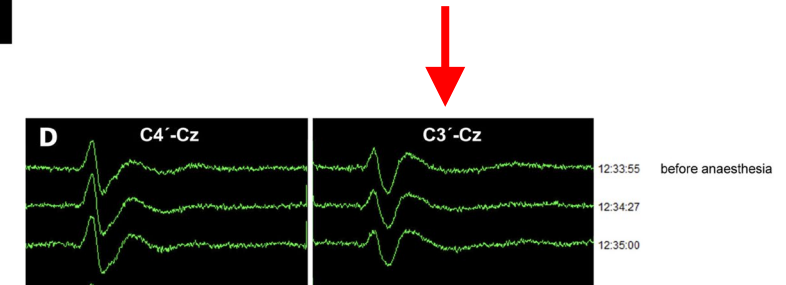
Svatopluk Ostrý^{a,b,*}, Milan Nevšimal^c, Miroslava Nevšimalová^a, Martin Reiser^a, Jiří Fiedler^{c,d}

Predikce outcome

LICA



Předoperační SEP n.M



Urgentní CEA

invalidita
závislost na péči
smrt

restituce příznaků
funkční nezávislost

Variable	Z value	p	r _s
MRC-UE	-2.443	0.0107	0.486
MRC-LE	-1.317	0.2158	0.265
NIHSS-door	0.413	0.6688	0.088
NIHSS-CEA	2.544	0.0060	0.506
OTF	0.171	0.8693	0.040
DTF	0.036	0.9716	0.014
SEP-amp	-2.902	0.0008	0.576
SEP-ratio	-3.105	0.0001	0.616

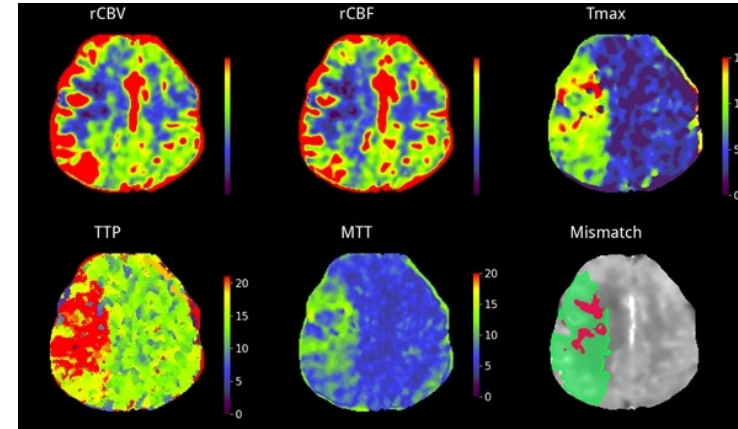
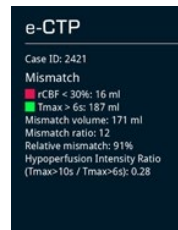


Kandidát rekanalizace eICA

Přežívání korových neuronů
před zahájením rekanalizace

Perfuzní zobrazení

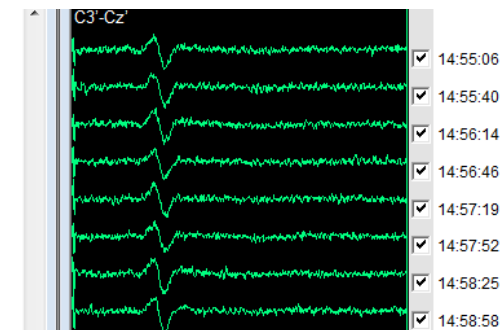
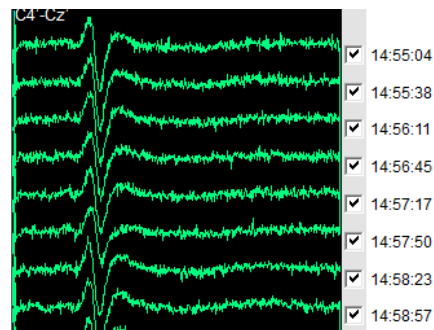
- nepřímá



Neuronální odpověď (SEP)

- přímá

amplituda SEP $\hat{=}$ rCBF



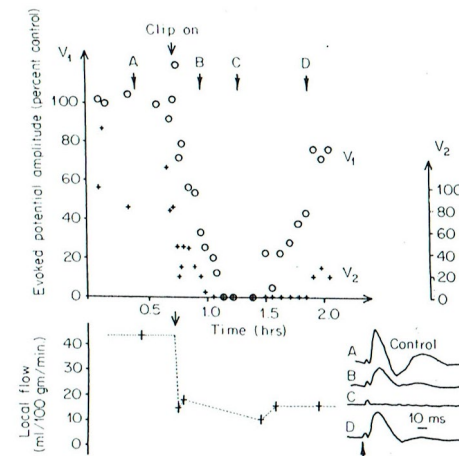
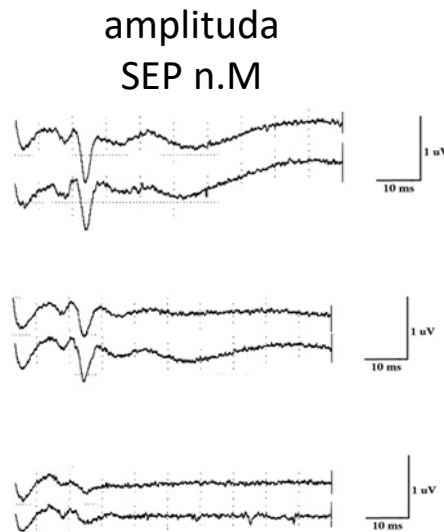
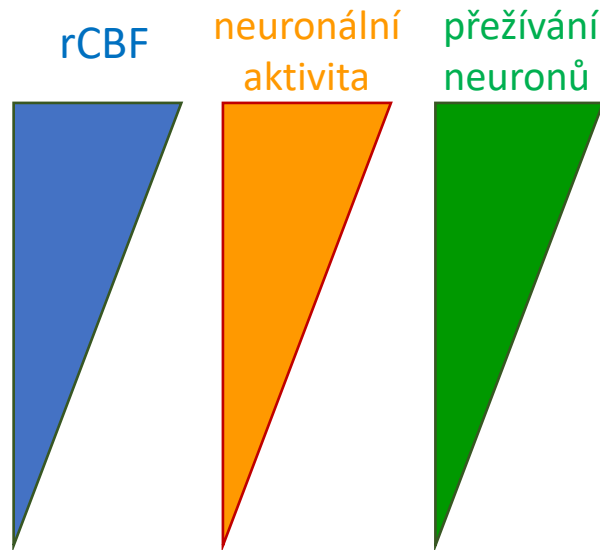
Monitorace korové perfúze

akutní hypoperfúze (pokles rCBF)

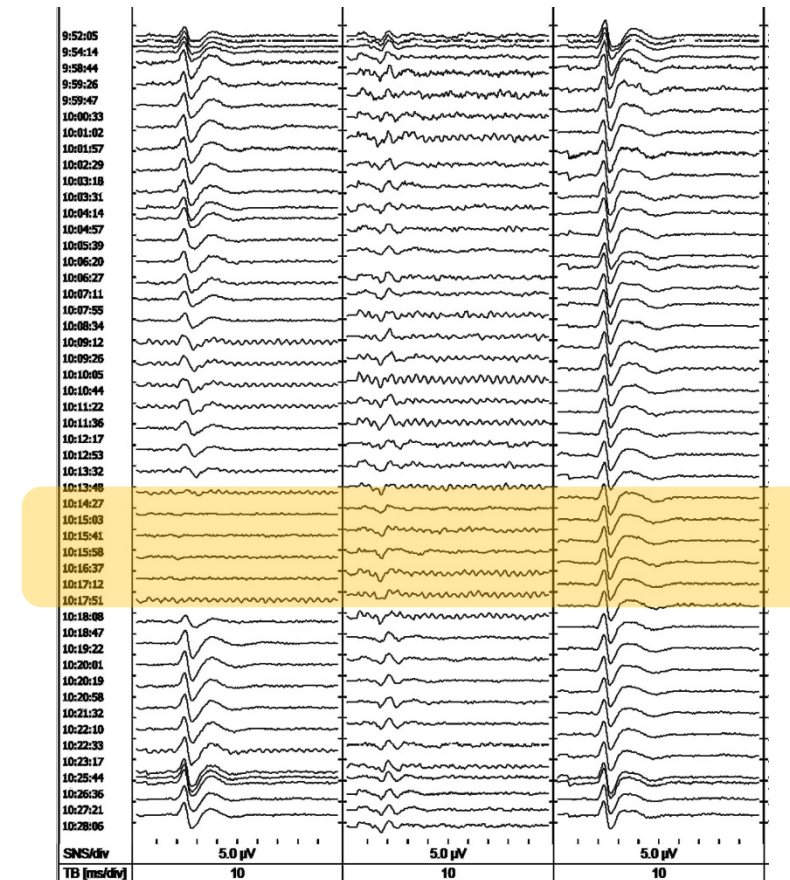
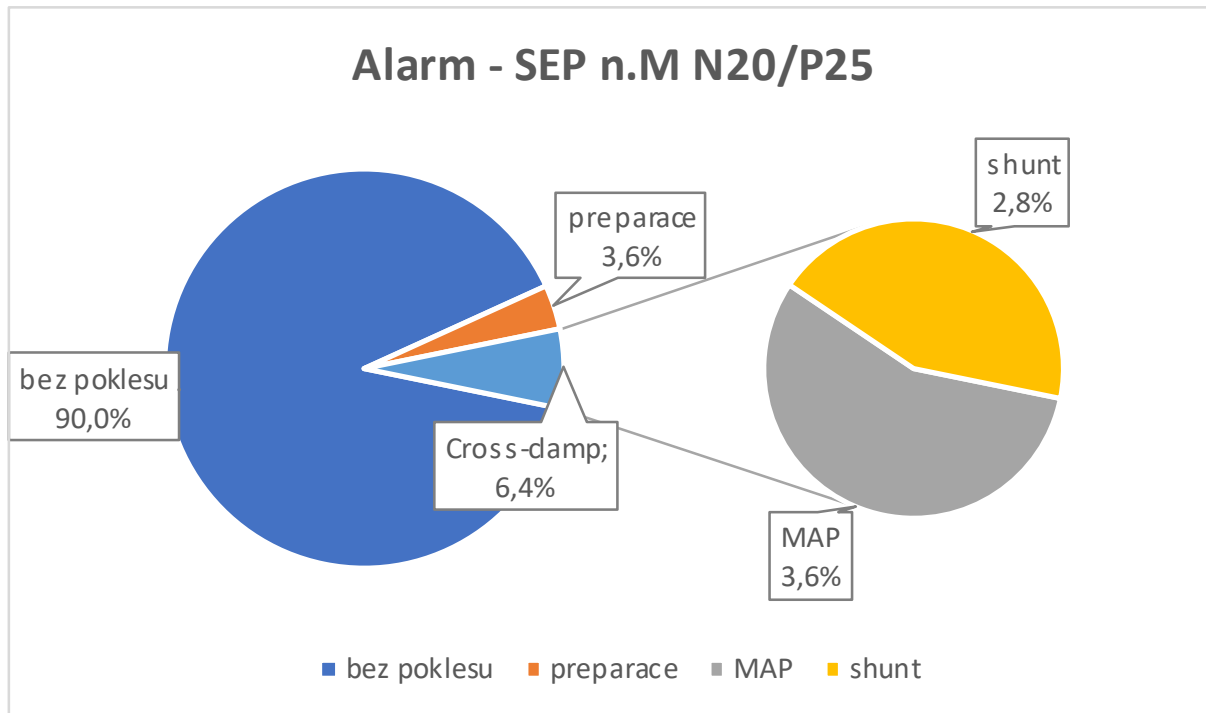
- CEA
 - cross-clamp
- akutní okluze eICA
 - primární okluze
 - cross-clamp

reperfúze (obnova rCBF)

- zvýšení systémového TK
- obnovení průtoku eICA
- shunt



obnova SEPs

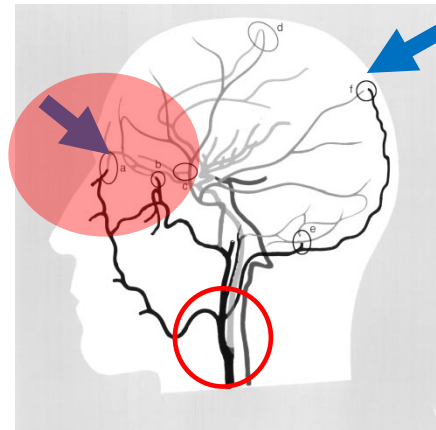
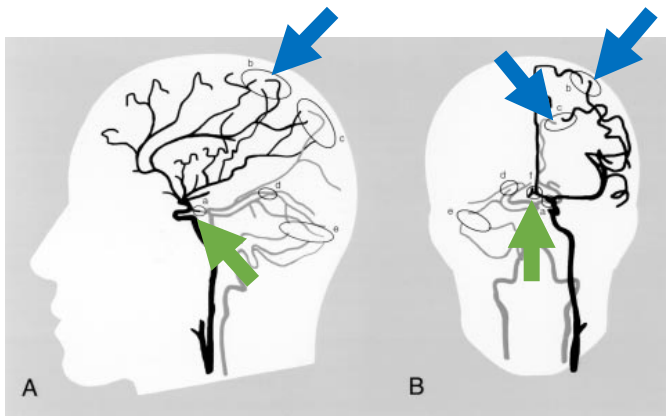


- Pokles amplitudy SEP N20/P25 je včasný varovný signál rozvoje ischemie vyžadující změnu operačního postupu.
- Změny EEG nastupují se zpožděním v porovnání se SEP.
- Monitorace průtoku pomocí TCD není spolehlivým indikátorem ischemie.

Intraoperační ischemie



AComA, PComm
OA (ECA), LC

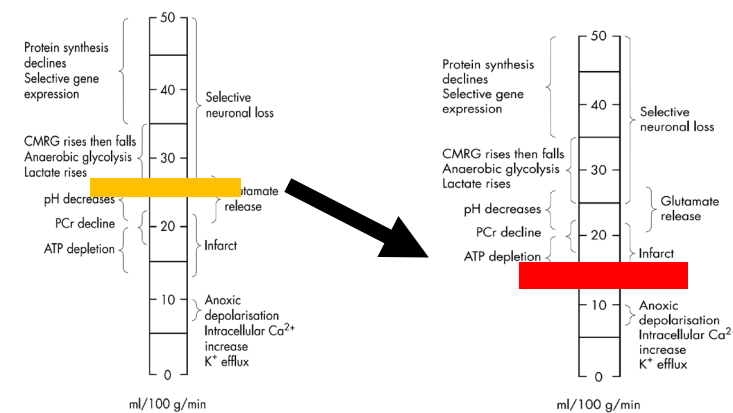


Cross-clamp CCA

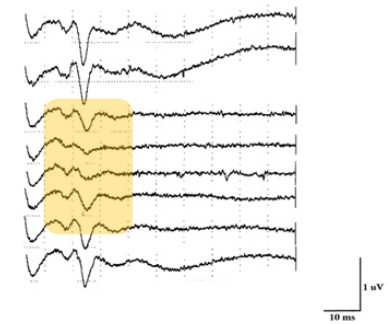
Intraoperative neurophysiological monitoring during urgent surgical extracranial internal carotid artery recanalization



Svatopluk Ostrý^{a,b,c,*}, Milan Nevšimal^d, Martin Reiser^a, Richard Voldřich^b, Ondřej Krčíčka^a, Jiří Kubále^e, Miroslava Nevšimalová^a, Jiří Fiedler^{d,f}



pokles SEPs
rozvoj ischemie



Liebeskind DS. Stroke. 2003 Sep;34(9):2279-84.
Markus HS. J Neurol Neurosurg Psychiatry. 2004 Mar;75(3):353-61.
Ostrý S, et al. Clin Neurophysiol 2022 Jun;138:221-230.



SEP n.M a urgentní rekanalizace eICA

Study	No	recanalization		clinical outcome		sICH	comment
		modality	rate	mRS 0-2	mortality		
Paciaroni et al. (2015)	324	endovascular	68.7%	32.4%	17.6%	37%	recanalization = TICI 2a,2b,3
Kappelhof et al. (2015)	38		71%	46%	28%	2%	
Gliem et al. (2017)	12		91.6%	50%	16.7%	25%	IVT + MT
Jadhav et al. (2018)	107		92%	65%	13%	7%	all ICH
Mizowaki et al. (2020)	19		84.2%	38.9%	10.5%	5.3%	
Benes et al. (2020)	175	surgery	93%	62%	5%	4%	
our study	33		93.9%	84.8%	9.1%	0%	wound hematoma 12.2%

IVT = intravenous thrombolysis, MT = mechanical thrombectomy, mRS = modified Rankin scale, sICH = symptomatic intracranial hemorrhage, TICI = treatment in cerebral ischemia score.

- Amplituda předoperačních SEP je spolehlivý prediktor klinického outcome.
- Změna operačního postupu vyvolaná intraoperačním poklesem amplitudy SEP n.M vede nejen k restituci korové perfúze, ale i zlepšení klinického výsledku urgentní rekanalizace.



Intrakraniální okluze a EP predikce

ICA, MCA, BA < 6h	eligible	90
	EP	20 (22,2%)
	MEP:	19 (95%)
	SEP:	9 (45%)

MCA < 8h	eligible	228
	SEP	168 (22,2%)

SEP before EVT	mRS ≤2 (n=60)	mRS >2 (n=108)
N20+, n (%)	56 (93.3)	54 (50)
N20-, n (%)	4 (6.6)	54 (50)

		perfúze	
		Cx	-
okluze	extrakraniální	Cx	Sc
	intrakraniální	SEP	MEP

Table 2 Diagnostic tests performances

	Sensitivity (%)	Specificity (%)	Positive predictive value (%)	Negative predictive value (%)
MEP	85	83	92	71
SSEP	83	66	83	66
Recanalisation	100	50	75	100

MEP, motor evoked potential; SSEP, somatosensory evoked potential.

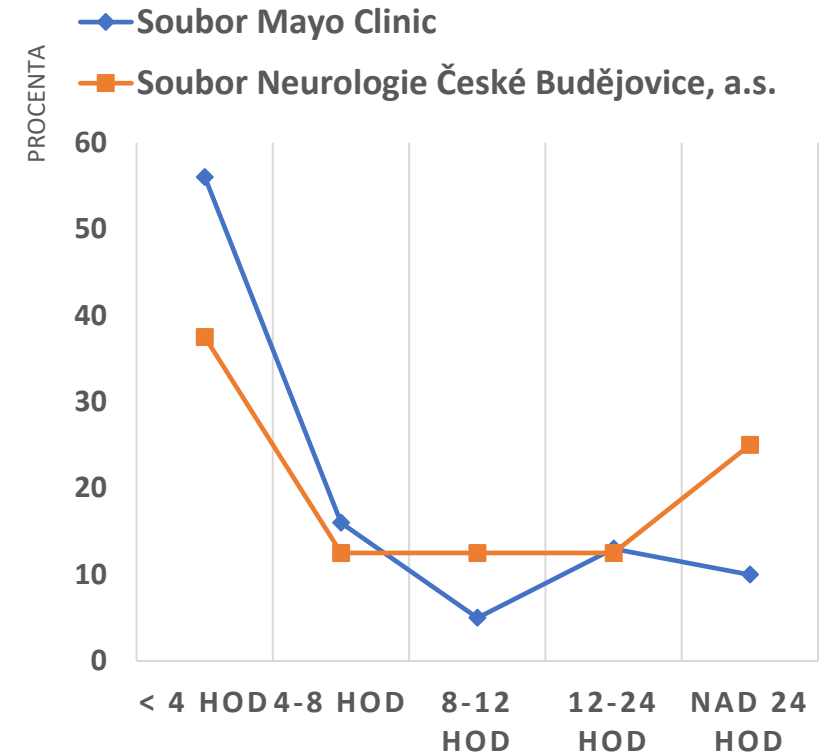
Míšní ischemie

Epidemiologie, klinický obraz

- 0,5-1% ischemických cévních příhod
- 6-16% transverzálních myelitid
- 85 % míšních příhod - ischemie

Klinická manifestace

- < 12h (1,5h - 31D)
- bolest 70%
- paréza 90-100%
- čítí
 - termické, algické 67%
 - vibrační 50%
 - hranice čítí 67-75%
- sfinktery, autonomní funkce 44%



Etiologie

TOAST

spontánní

- aterosklerotická 33 - 68 %
- kardioembolizace 22 %
- disekce aorty 5-11 %
- CSM 11 - 14 %
- disekce VA, hyperkoagulační stav, systémová hypotenze či vaskulitida

Rizikové faktory

- HT, HLP, DM, kouření

sekundární

- NCH - IMSCT
- KCH - AN aorty 3-33%

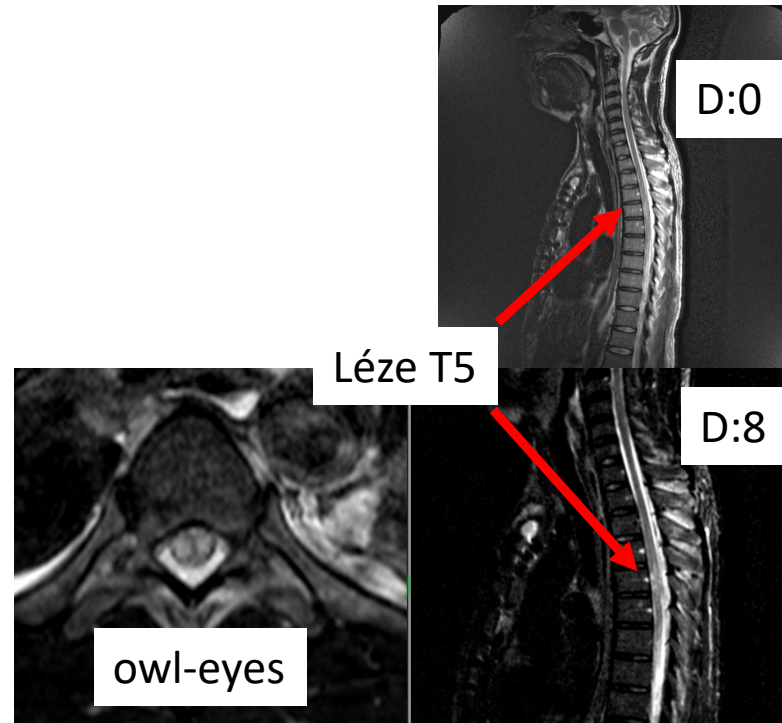
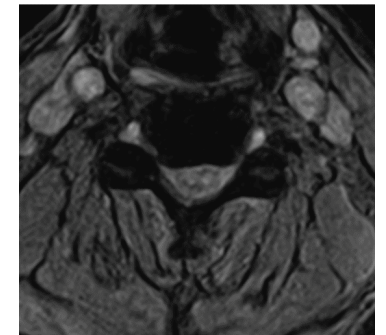
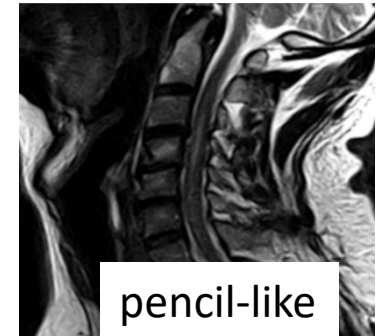
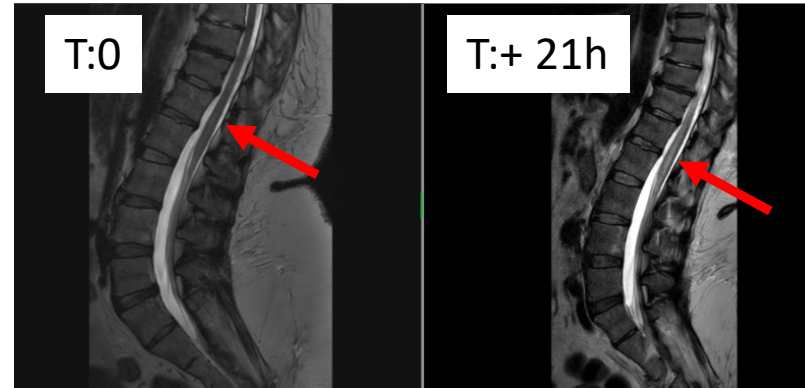
Diagnostika

MRI-patterns

owl-eye
pencil-like
U/V lettershape
anteromedial spot
hologrey
holocord

	min [h]	median [d]	%
T2-WI	8	3	65
DWI	24	1	67
Gd+	72-96	10	39

CTA, MRA, DSA - 20% abnormita (AN Ao, okluze, sAVM)
CSF - P-C disociace
EP - funkční průkaz multifokální léze



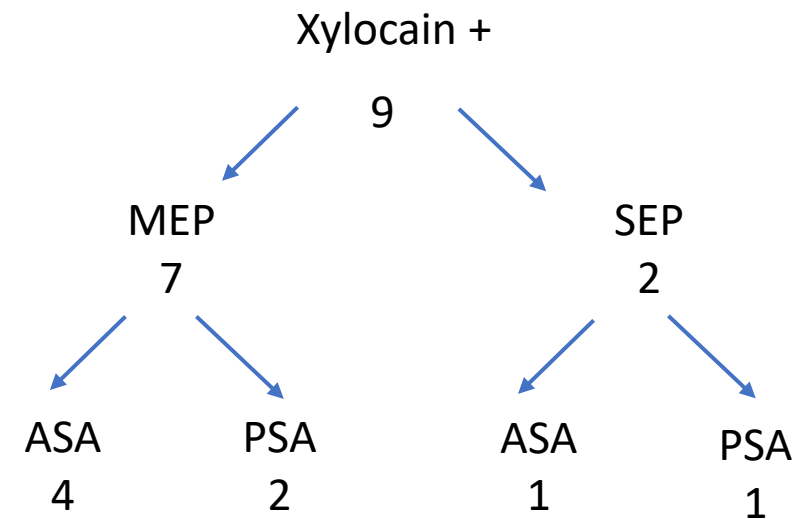
Provokační testy - embolizace sAVM

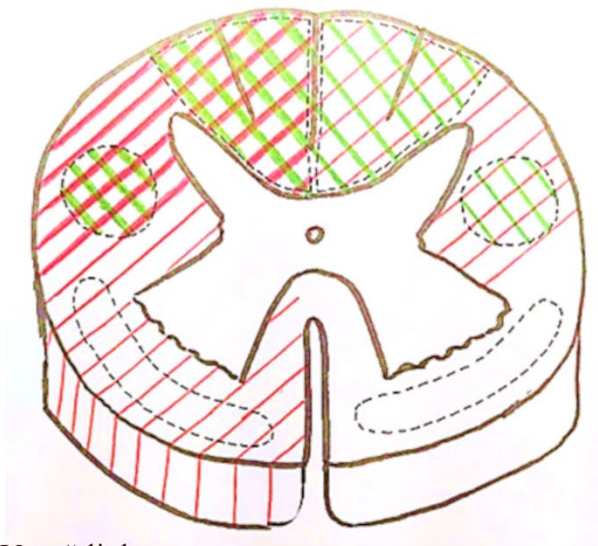
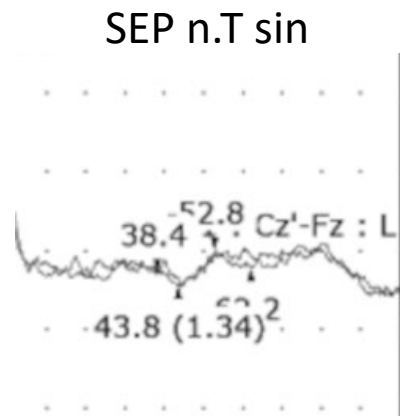
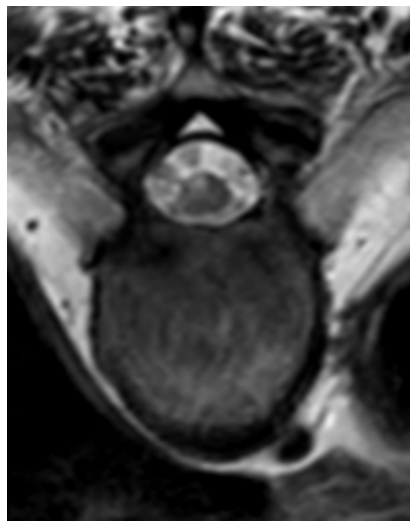
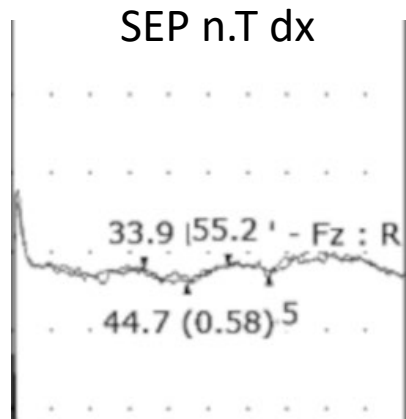
Xylocain
Amytal

Ischemické postižení míchy

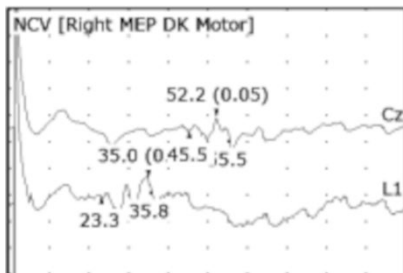
Šedá hmota
Multifokální

- vertikálně
- horizontálně



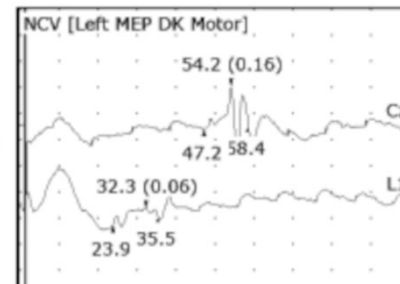


MEP AH dx



Vysvětlivky:
červeně šrafovaná oblast – klinické postižení
zeleně šrafovaná oblast – postižení dle vyšetření evokovaných potenciálů

MEP AH sin



Vysvětlivky:
červeně šrafovaná oblast – porucha vibračního čítí
zeleně šrafovaná oblast – porucha termického a algického čítí
oblast modře tečkovaná – postižení svalové síly

Terapie a prognóza

Terapie specifická neexistuje
intenzivní FT (SJ)
symptomatická
podpůrná

- APT
- vaskulární RF
- CSF drenáž - perfúzní tlak míchy ?
- IVT - není průkaz účinnosti !
- naloxon ?!
- steroidy ?!

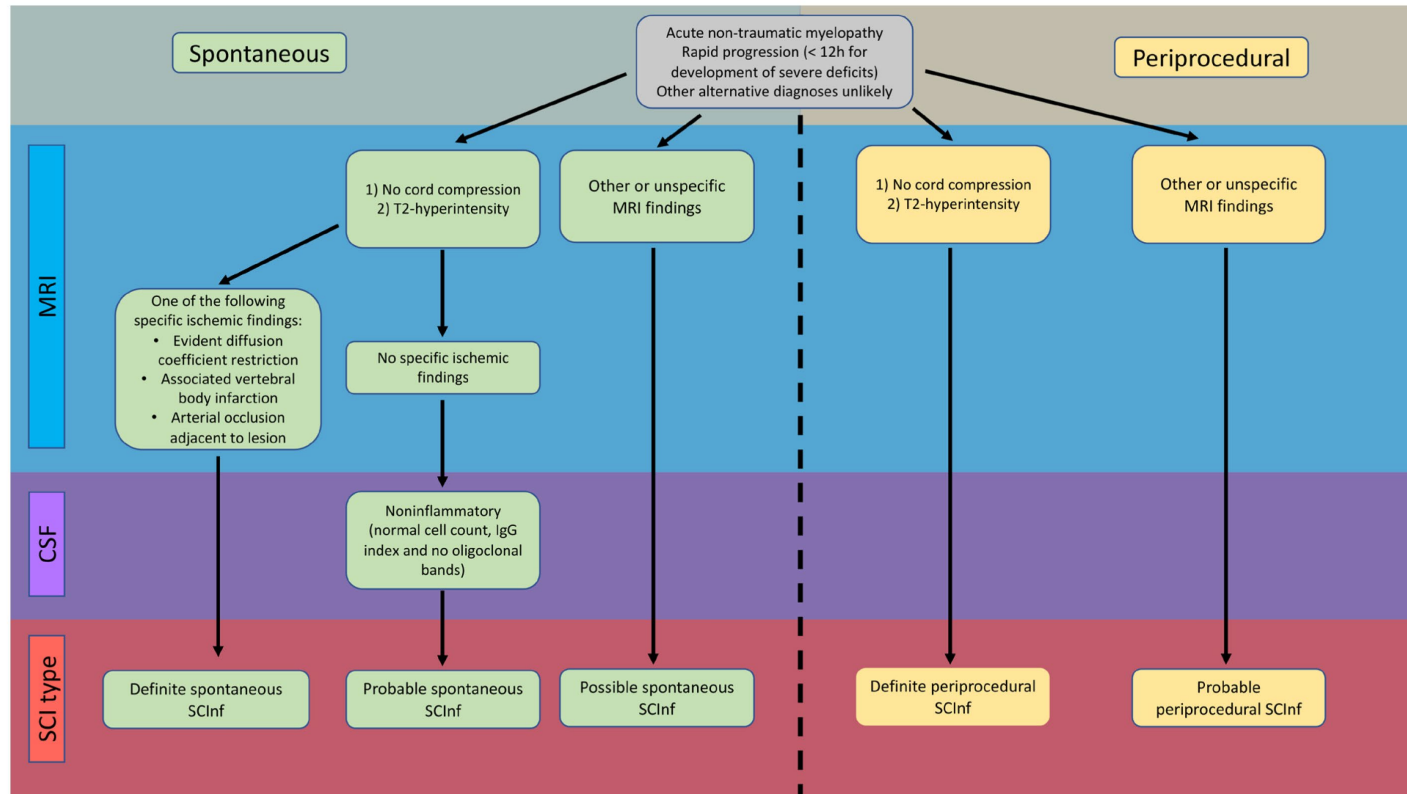
Outcome

- 38-70% chodící (bez opory 30-47%)
- sfinkterové dysfunkce

Prognóza

- multisegmentové postižení
- rychlá progresse deficitu
- ASIA
- věk

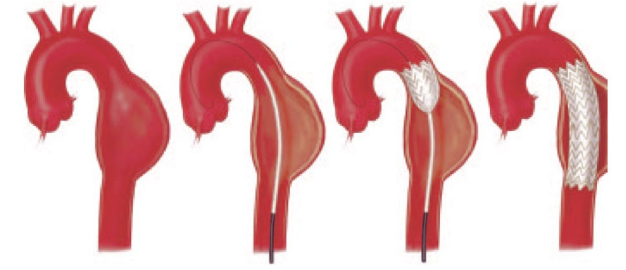
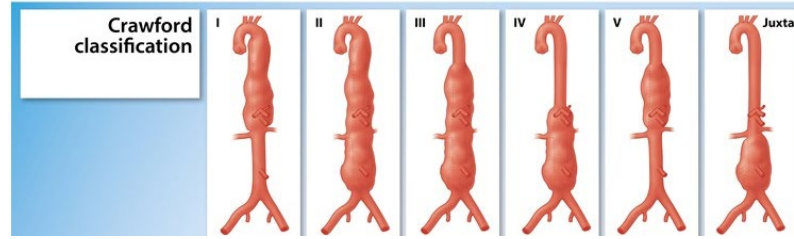
Kritéria pro míšní ischemii



Klinika
MRI
CSF

- transverzální míšní léze < 12h
- absence expanze, komprese
- absence zánětu

Sekundární - SCI



Incidence pooperační paraplegie: 3,1-33,5%

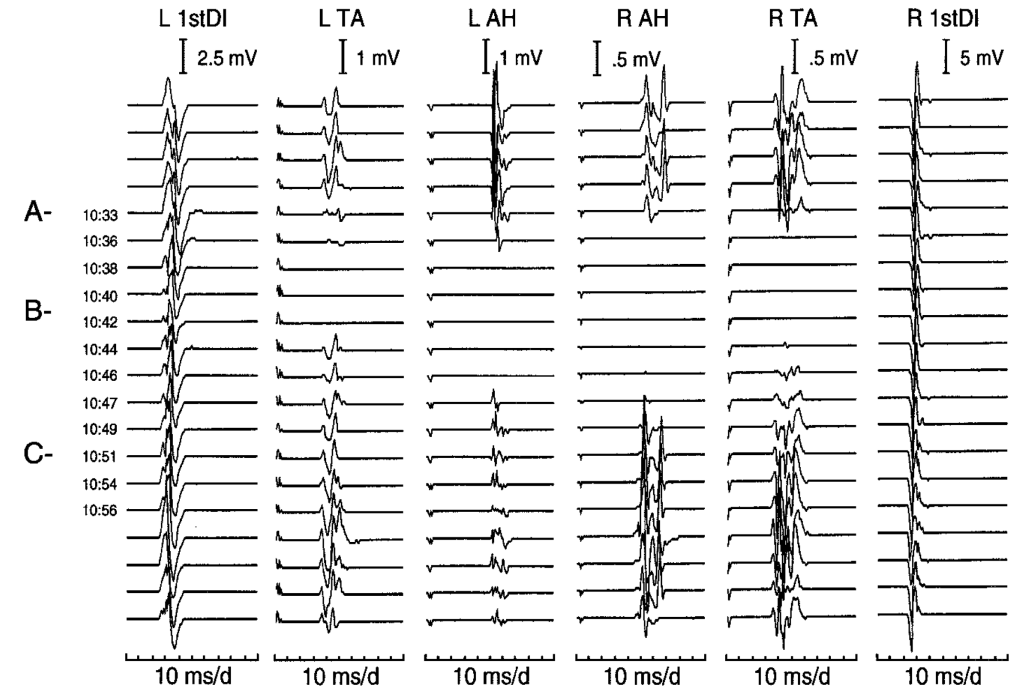
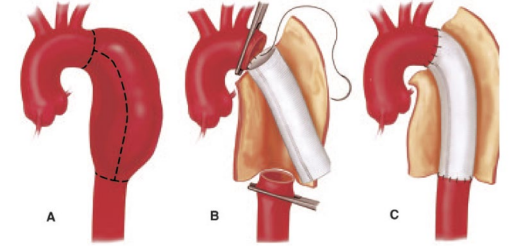
Intraoperační management SCI:

- hypotermie
- CSF drenáž
- řízená hypertenze
- naloxon
- methylprednisolonu
- IOM - SEP - optional (1x)

mIONM - mMEP
 - nMEP
 - SEP,
 - EMG

vulnerabilita

šedá hmota > bílá hmota



Lella SK et al. J Vasc Surg. 2022 Mar;75(3):1091-1106.
 Bianchi F et al. Neurophysiol Clin. 2022 Jun;52(3):232-241.
 MacDonald DB, Janusz M. J Clin Neurophysiol 2002, 19(1):43-54.

