

I. OS. - alternativa PIV v urgentní situaci

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Oddělení urgentního příjmu FN USA, Brno

XVII. Konference Akutně.cz

22. 11. 2025





(X)ABCDE



I. OS. VSTUP= 1. ALTERNATIVA K NEZDAŘENÉMU PIV



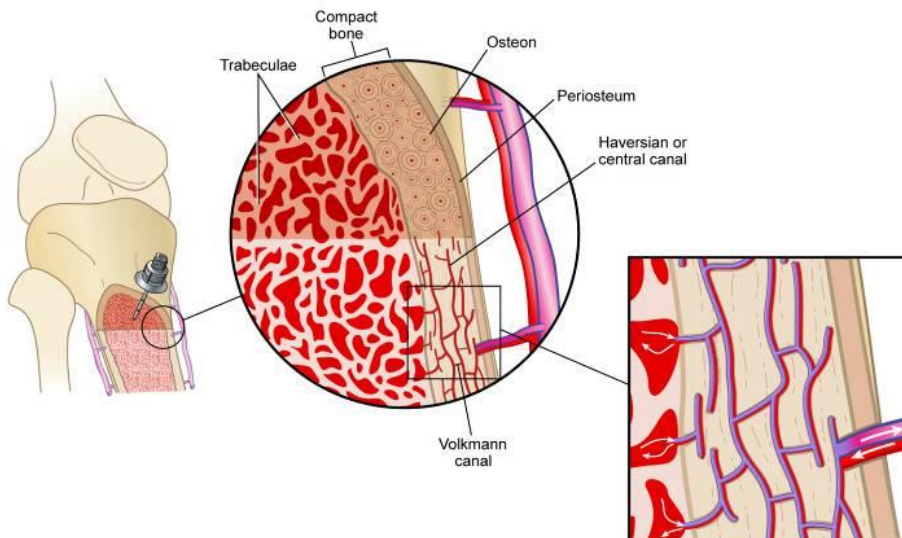
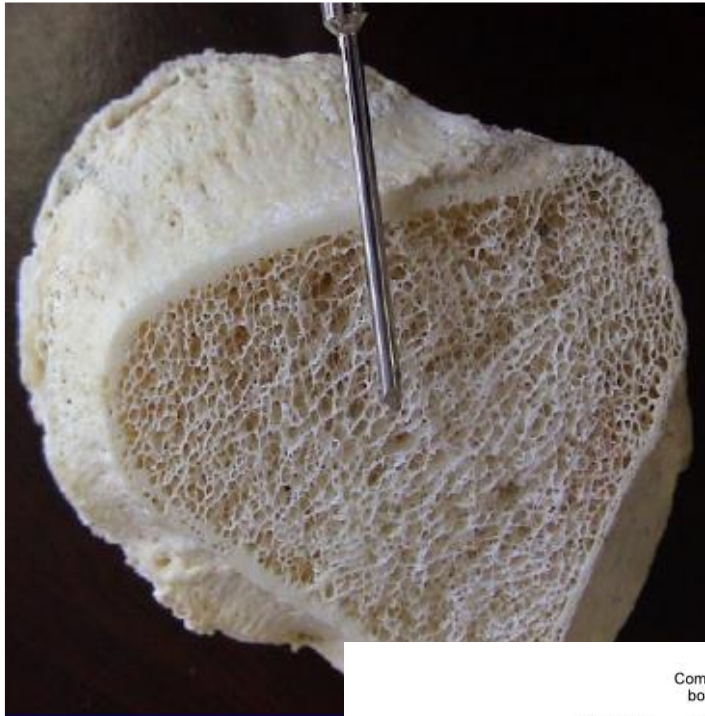
**EUROPEAN
RESUSCITATION
COUNCIL**



- Děti zástava oběhu nebo dekompenzovaný šok, kdy je vysoká pravděpodobnost, že PIV nepůjde zajistit i. os = 1. volba (manuál EPALS, CPR GL 2025)
- EPALS, ALS, ATLS, PHTLS, TCCC.....

Proč to funguje?

- Ve dřeni hustá síť cév
- Krevní proud rychlý
- Dřeň nezkolabuje
- Léky a tekutiny rychle dosáhnou centrálního cévního řečiště **IO = PIV = efektivní varianta PIV**



Miller, LJ, Kuhn JG, Von Hoff, DD. Does IO equal IV? Prehosp Emerg Care 2005; 9:102

1922 – Drinker et al. – léky a infúze aplikované do kostní dřeni (sternum) se rychle vstřebají do centrálního řečiště

1942 - Papper – doba vstřebání léků do centrálního řečiště je u IV podání a IO identická



Application Times, Placement Accuracy, and User Ratings of Commercially Available Manual and Battery-Powered Intraosseous Catheters in a High Bone Density Cadaveric Swine Model

Victoria C. Kay, MD^{ID},[†]; Joseph A. Gehrz, MD[†]; Derek W. Grady, MD[†],[‡]; Alec D. Emerling, MD[†],[‡];
Andrew McGowan, MD[†],[‡],[§]; Erin R. Reilly, MPH[†],[‡]; Vikhyat S. Bebart, MD^{||},[¶];
Joshua Nassiri, MD[†],[‡],[§]; Jorge Vinals, PhD^{**}; Andrew Schrader, DVM^{††}; Gregory J. Zarow, PhD[†],^{‡‡};
Jonathan D. Auten, DO[†],[§]

Arrow EZ-IO

Jamshidi IO

PerSys NIO 2

SAM IO

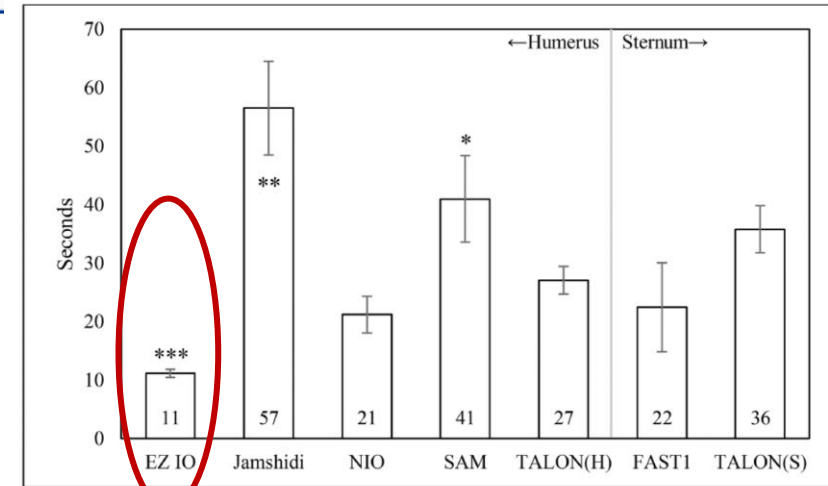
TALON

Arrow EZ-IO™ - EZ (Easy) IO
(IntraOsseal) access

Target Pa

Sharps Plug

Cover

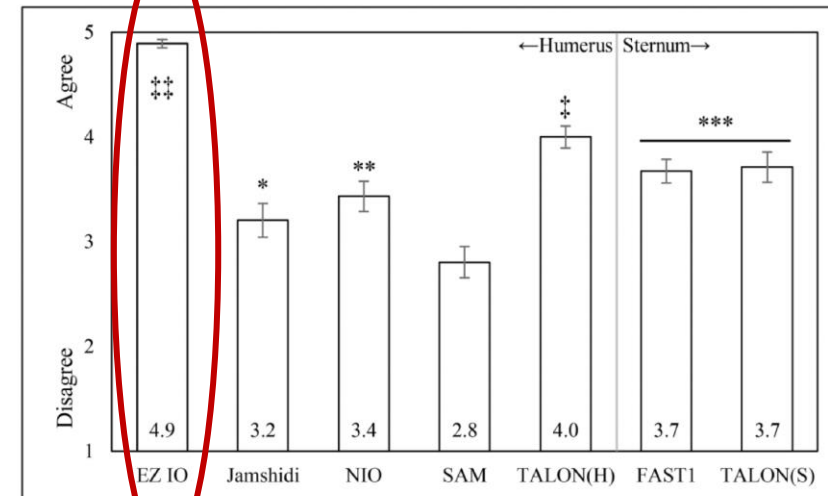


***p<.0001 versus all others

**p<.0001 versus NIO, FAST1; p<.001 versus TALONH; p<.01 versus TALONH; p<.05 versus SAM

*p<.05 versus NIO, FAST1

IO End-User Ratings



+++p<.0001 versus all others

++p<.0001 versus Jamshidi and SAM, p<.01 versus NIO

***p<.0001 versus SAM, p<.01 versus Jamshidi

**p<.01 versus SAM

*p<.05 versus SAM

ORIGINAL RESEARCH

Open Access

Efficacy of the EZ-IO[®] needle driver for out-of-hospital intraosseous access - a preliminary, observational, multicenter study

Richard Schalk¹, Uwe Schweigkofler², Gösta Lotz¹, Kai Zacharowski¹, Leo Latasch³ and Christian Byhahn^{1*}

Table 1 Indications for EZ-IO[®] use in 74 patients

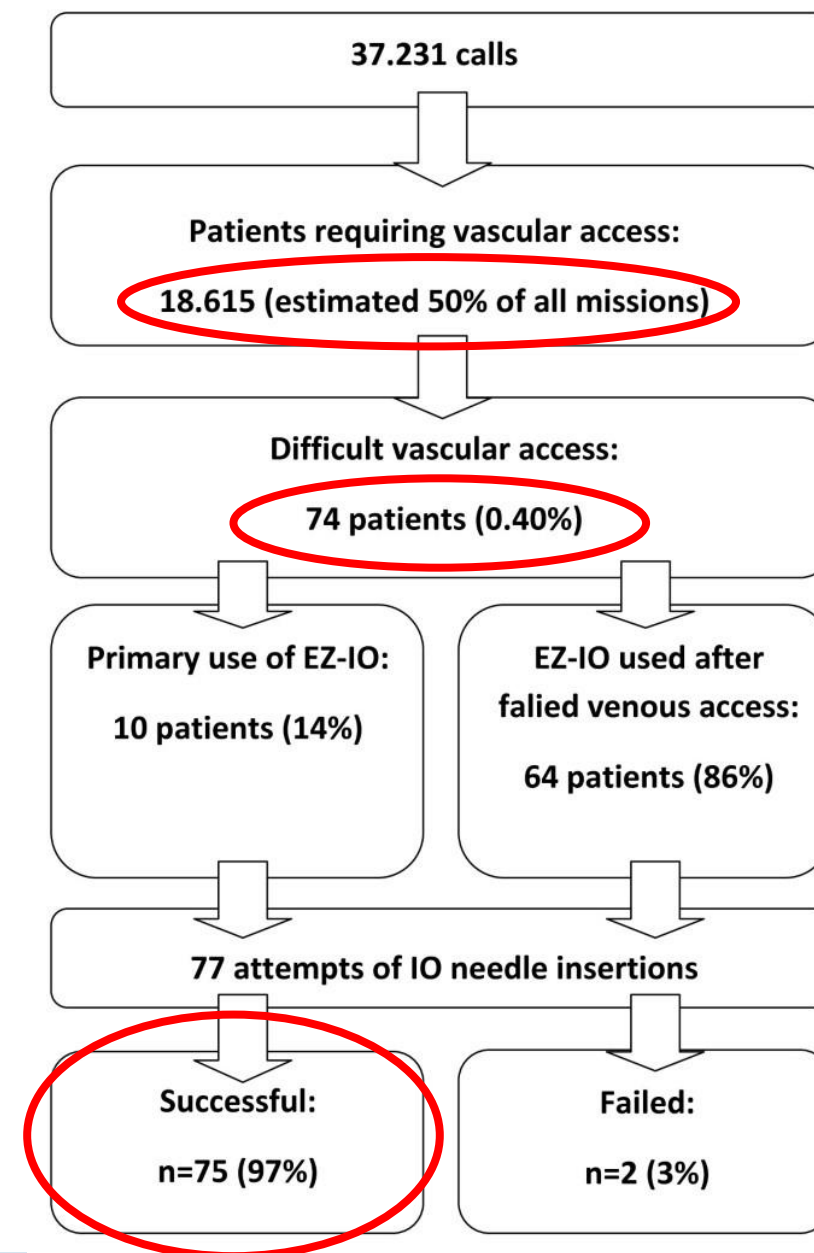
Diagnosis	n and (%)
Cardiac arrest	41 (56%)
Multiple trauma	15 (20%)
Myocardial ischemia	5 (7%)
Pulmonary edema	4 (5%)
Drug poisoning	4 (5%)
Stroke/Intracerebral hemorrhage	3 (4%)
Gastrointestinal hemorrhage	2 (3%)

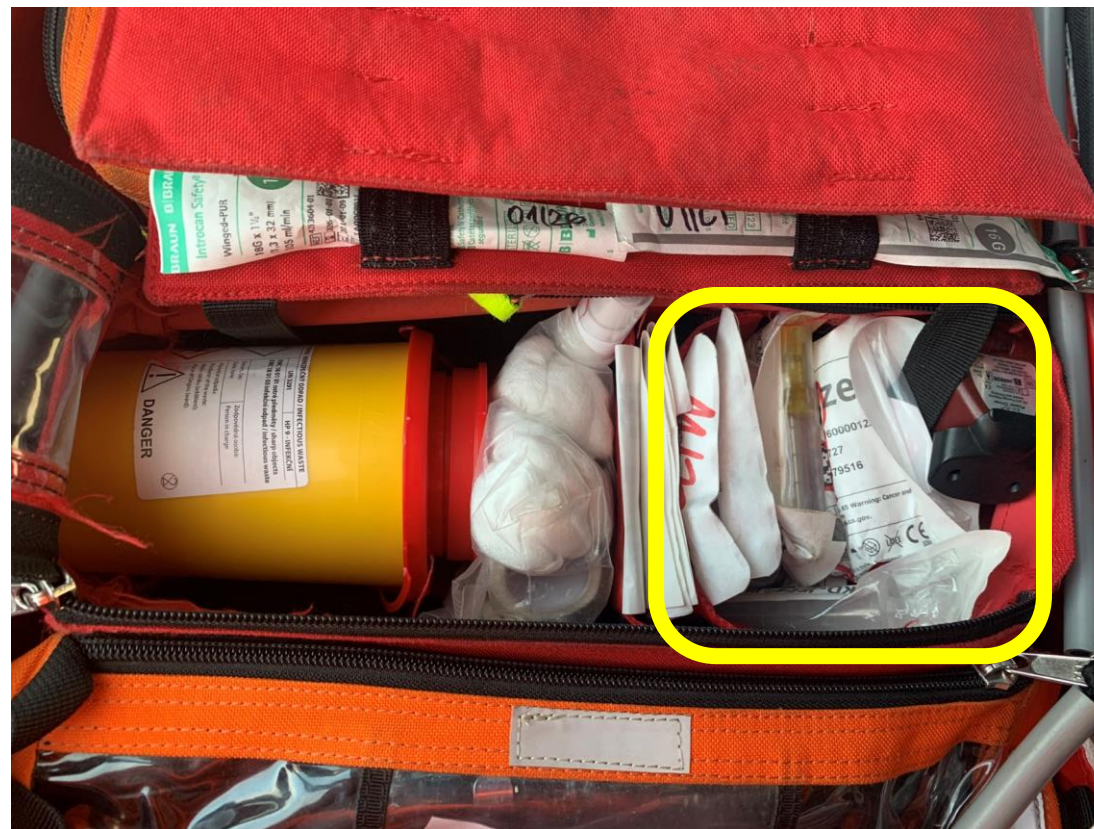
Table 2 Previous personal experience with IO needle placement

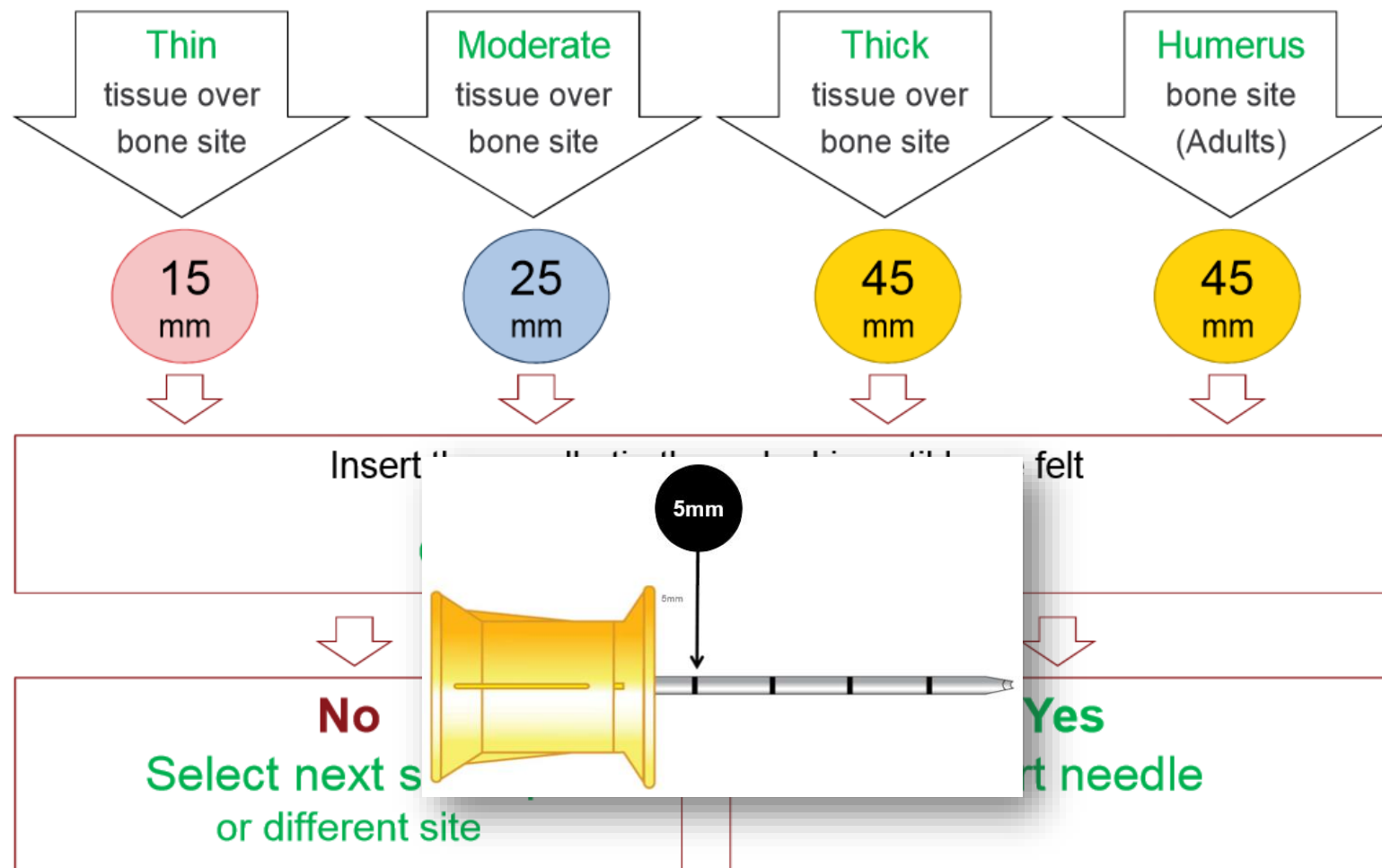
Previously placed intraosseous needles (n = 63 EP/PM)*			
None	1-5	6-10	> 10
25 (40%)	32 (50%)	3 (5%)	3 (5%)

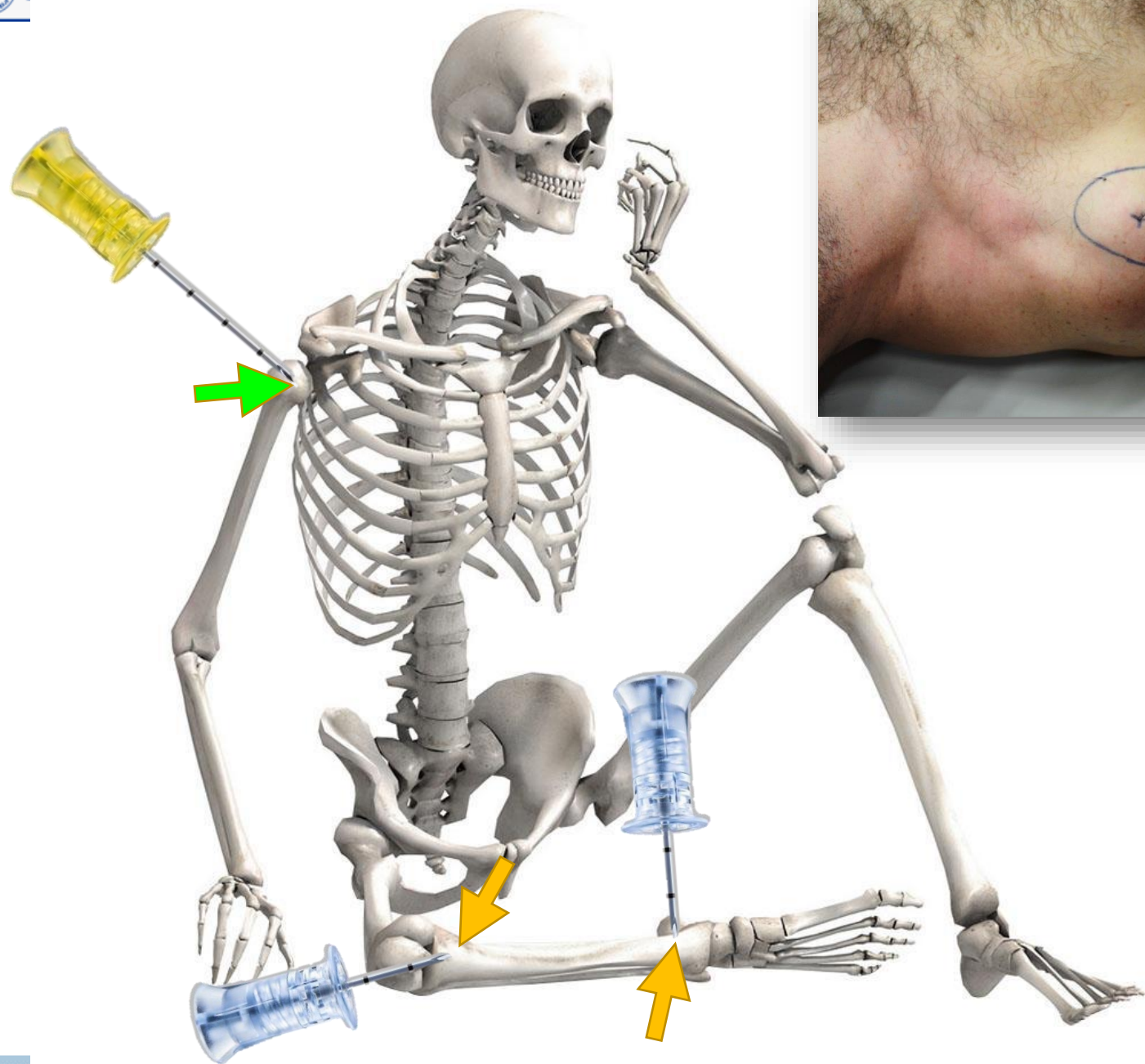
Data are number and (%)

EM: emergency physician PM: paramedic





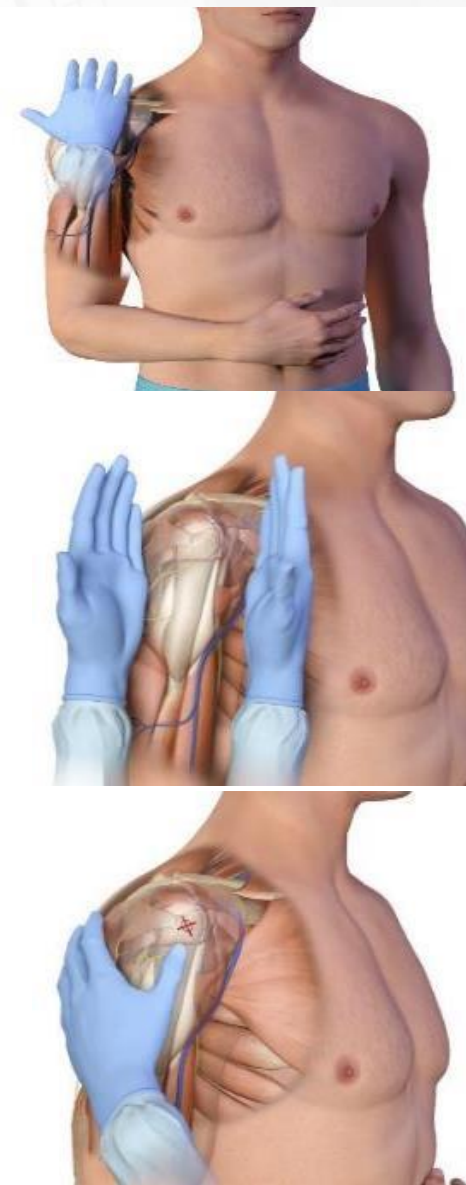
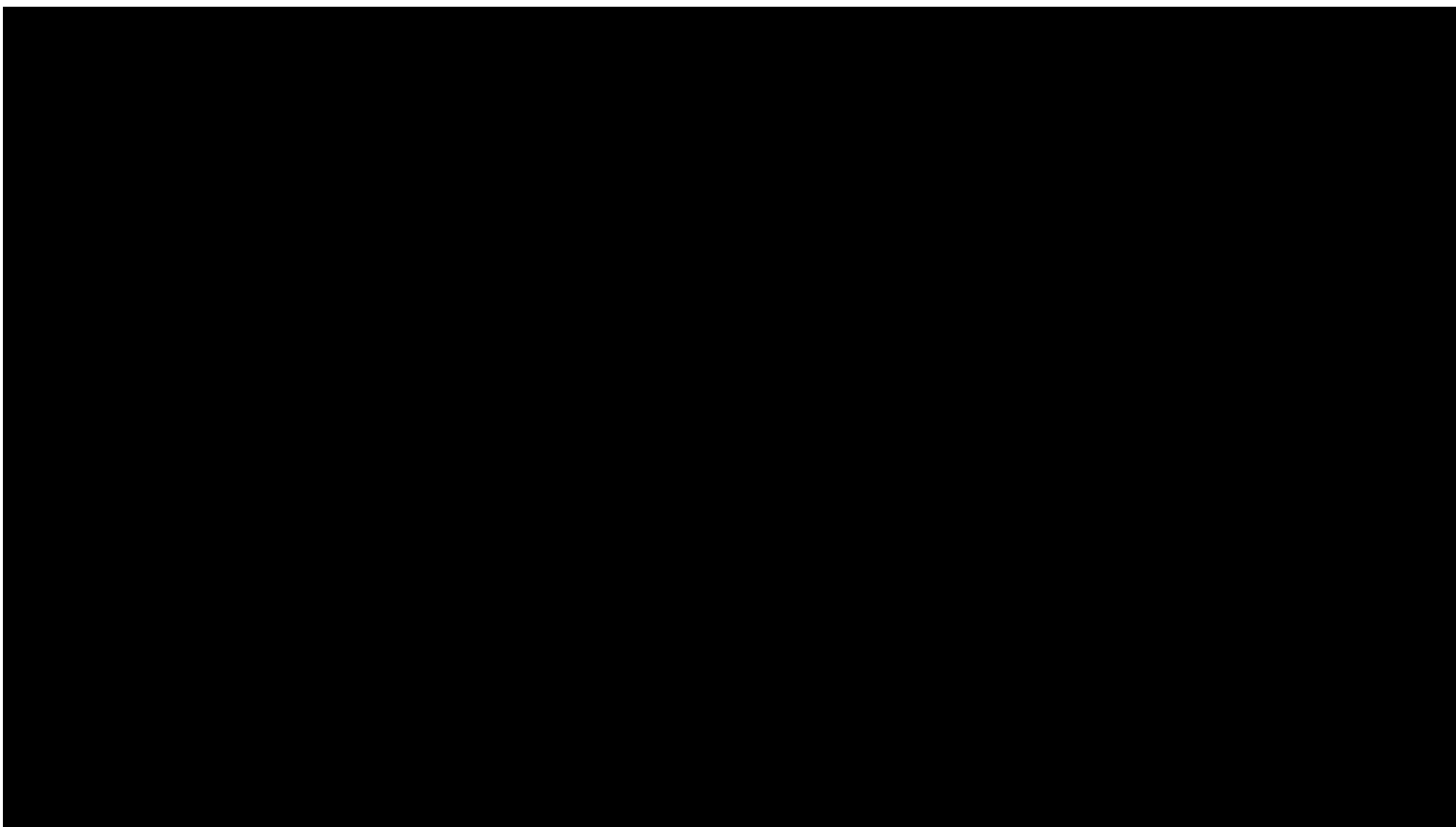




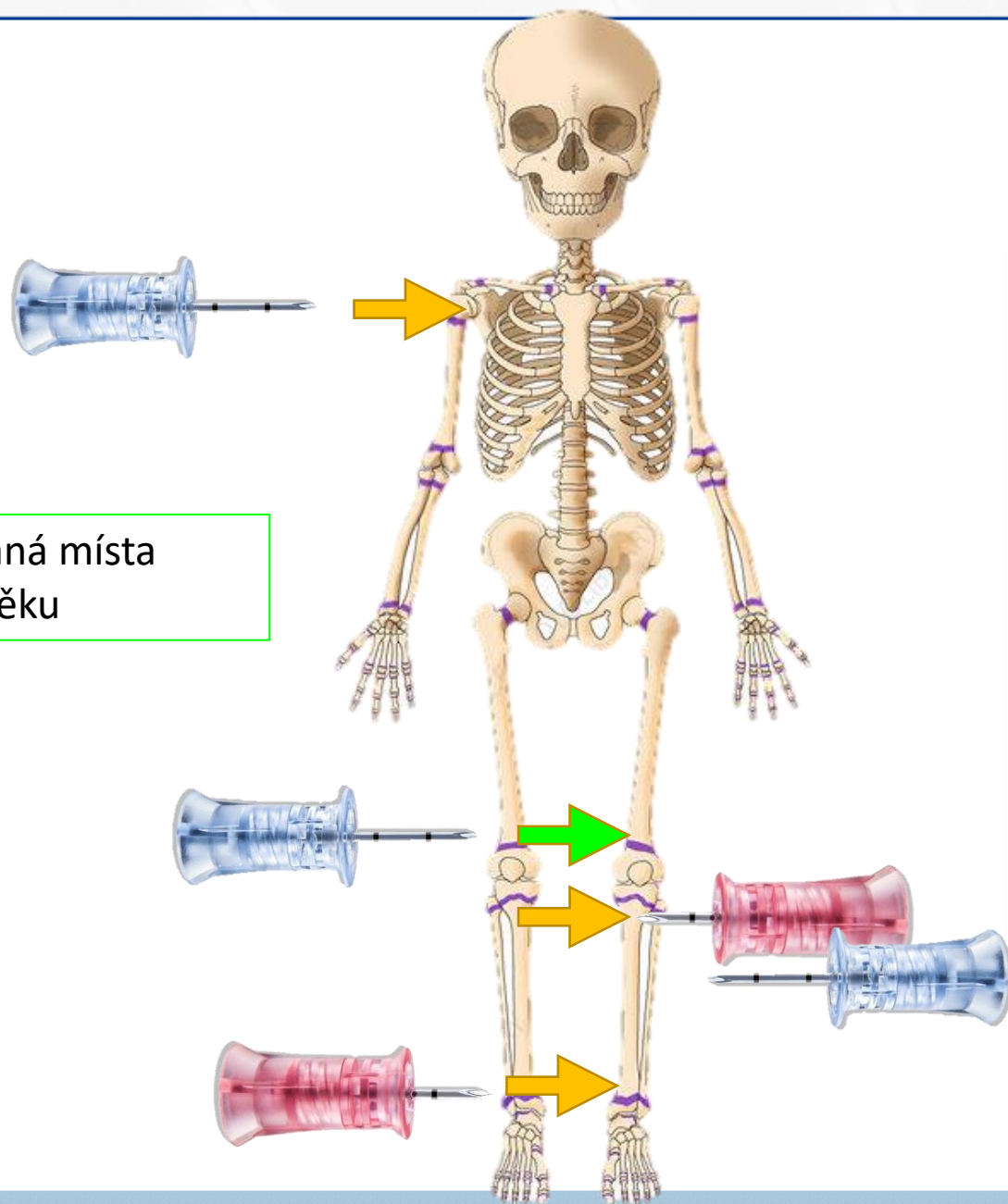
Preferovaná místa
> 22 let věku



Proximální humerus – vyhledání místa vpichu

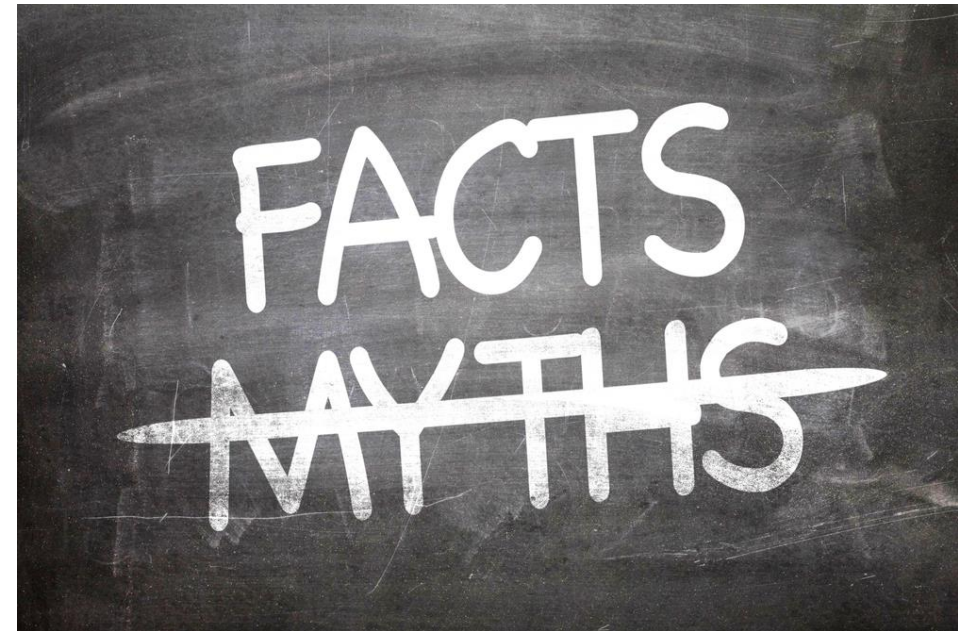


Preferovaná místa
< 21 let věku



Mýty? Fakta? Otázky?

- CVK je zavedený stejně rychle?
- Průtok je pomalý?
- Laboratorní odběr?
- Riziko vážných komplikací?
- Je pro i. os. ještě místo v době ultrazvukové?



Participants	Grading						Insertion time			Attempt		
	[1 = excellent to 6 = failure]						[sec]			[number]		
	Participant			Observer								
	EZ-IO tibia	EZ-IO humerus	FASTR	EZ-IO Tibia	EZ-IO humerus	FASTR	EZ-IO tibia	EZ-IO humerus	FASTR	EZ-IO tibia	EZ-IO humerus	FASTR
Mean value	1.3	2.0	1.6	1.0	1.4	1.1	17.0	29.1	32.6	1.1	1.2	1.1
Standard deviation	0.5	0.8	0.8	0.2	0.6	0.2	7.2	42.3	20.6	0.3	0.4	0.2
Median	1	2	1	1	1	1	15	19	30	1	1	1
Minimum	1	1	1	1	1	1	8	5	14	1	1	1
Maximum	2	3	3	2	3	2	33	210	110	2	2	2
p value (ANOVA)	0.008			0.012			0.165			0.209		
post hoc analysis (if applicable)	Rychlost zavedení											
EZ-IO tibia vs. EZ-IO humerus	0.006			0.025								
EZ-IO humerus vs. FASTR	0.390			0.039								
EZ-IO tibia vs. EZ-IO humerus	0.349			1.0								

doi:10.1371/journal.pone.0143726.t001

Rychlost zavedení

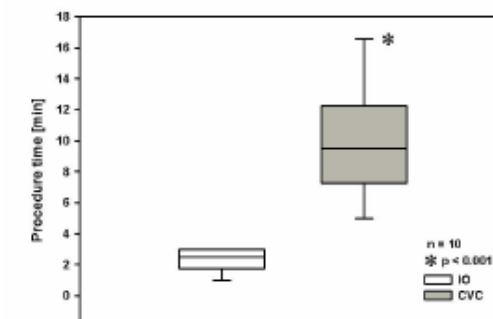


Figure 3
Procedure time of intraosseous (IO) cannulation was significantly shorter than central venous catheterization (CVC) for vascular access to enable drug and fluid administration in adult emergency patients under resuscitation.

Liedel et al.

Flow rate



Table 2 Comparison of flow rates with/without pressure bag

Flow rate	Tibia (mL/min)	Humerus (mL/min)
No pressure bag	73.0 (35.4)	84.4 (37.5)
With pressure bag	165.3 (112.5)	153.2 (65.0)
Difference	-92.3	-68.8
95% CI	-132.2 to -52.3	-99.0 to -38.7

Published in The American journal of emergency medicine 2009

[An observational, prospective study comparing tibial and humeral intraosseous access using the EZ-IO.](#) M. Ong, Y. Chan, J. Oh, A. Ngo

467

A Two-Phase Study of Fluid Administration Measurement During Intraosseous Infusion

Miller L, Philbeck T, Montez D, Puga T/Vidacare Corporation, San Antonio, TX

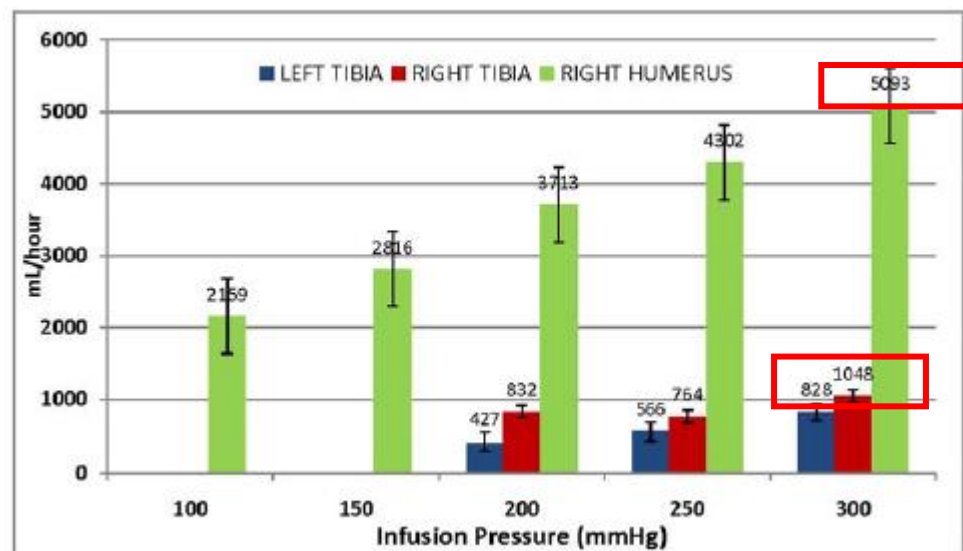


Table 2 Flow rates of devices

Intravenous catheter	Rate of flow with gravity (ml/min)	Rate of flow with pressure (ml/min)	Rate of flow with Bionector (ml/min)	Percentage increase with pressure	Percentage decrease with Bionector
14G 50 mm cannula	236.1	384.2	138.3	62.7%	-41.4%
14G 14 cm Abbocath	197	366	131.3	85.8%	-33.4%
16G 50 mm cannula	154.7	334.4	109.6	116.2%	-29.2%
14G 15 cm Leadercath	117.3	211.1	101.1	80%	-13.8%
18G 45 mm cannula	98.1	153.1	80.3	56%	-18.1%
16G distal port triple lumen central line	69.4	116.1	67.4	67.3%	-2.88%
20G 33 mm cannula	64.4	105.1	58.5	63.2%	-9.17%
22G 25 mm cannula	35.7	71.4	34.7	100%	-2.80%
18G proximal port triple lumen central line	29.7	79.3	28.7	167%	-3.37%

79

Intraosseous Pressure Infusion Comparison Using a Rapid Infusion Device and a Pressure Bag In a Swine Model

Laiet JR, Bebart V, Laiet K, Kacprowicz R, Johnson R, Pitotti R, Bolleter S, Cowart J, Bush A/Wilford Hall Medical Center, San Antonio, TX; US Army Institute of Surgical Research, Ft Sam Houston, TX; Wright Patterson AFB, WPAFB, OH; San Antonio AirLife, San Antonio, TX; 59th Clinical Research Division, San Antonio, TX

Site	Rate of infusion (mL/min)	Mean pressure (mmHg)
Proximal Humerus PB	115	394 (380 - 422)
Proximal Humerus RID	79	239 (180 - 278)
Proximal Tibia PB	81	471 (458 - 491)
Proximal Tibia RID	47	270 (260 - 288)
Femoral Vein Introducer PB	170	147 (133 - 155)

PB = pressure bag system; RID = rapid infusion device; Rate = mL/min; Pressure = mmHg

Průtok kanylou

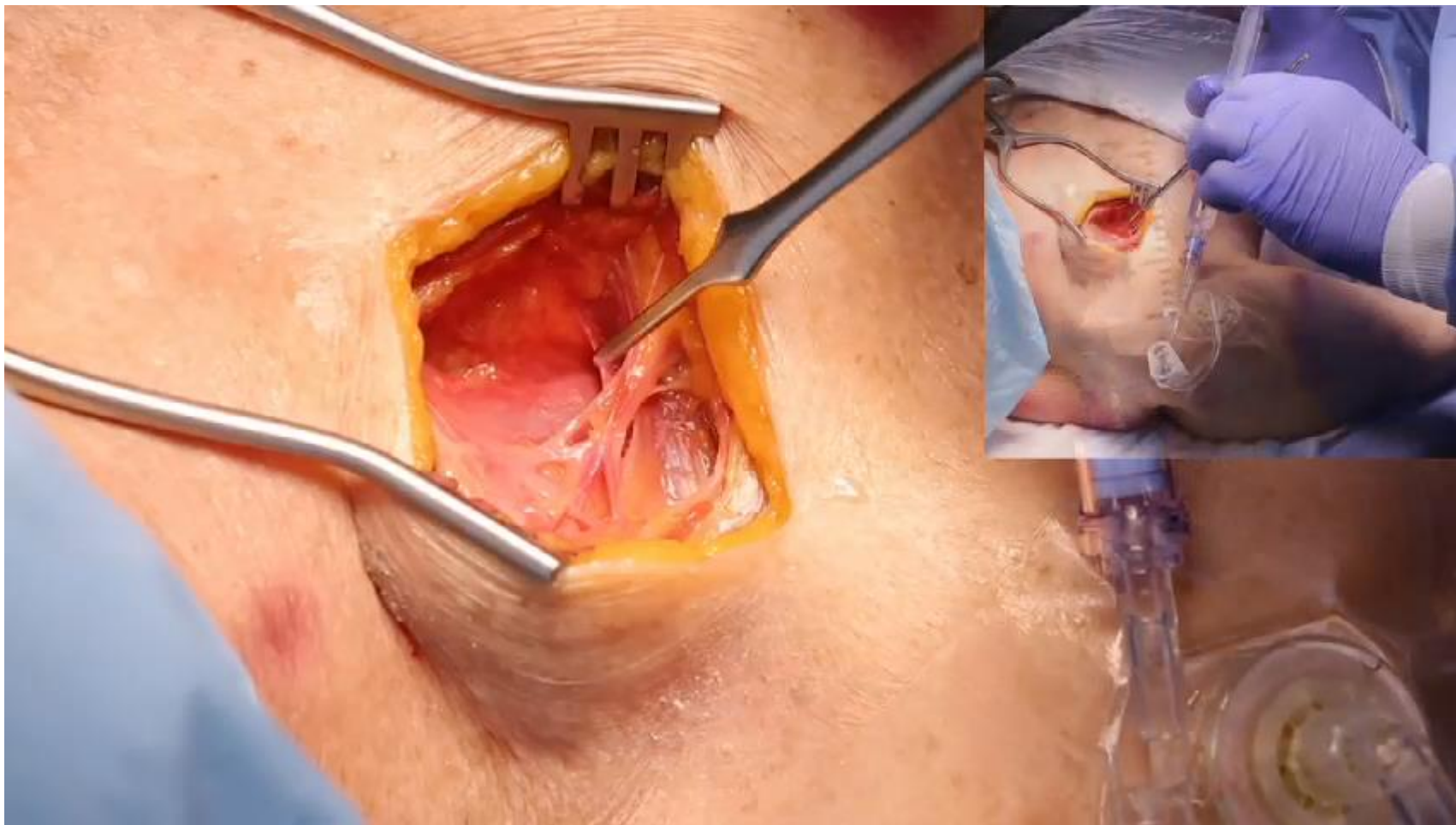
- Hagen-Poiseuilleův zákon: $Q = \pi r^4 \cdot \Delta P / 8 \mu l$

- Q = průtok
- r = poloměr kanyly
- ΔP = tlakový gradient mezi začátkem a koncem
- M = viskozita podávaného roztoku
- l = délka kanyly

⇒ průtok závisí přímo úměrně na čtvrté mocnině poloměru

⇒ průtok krátkou kanylou zavedenou do PŽ ($l=4,5\text{cm}$) bude min. $3\times\uparrow$ než průtok katétrem téhož kalibru zavedeném do CŽ ($l=15 - 20\text{cm}$)

Průtok kanylou



POC laboratorní diagnostika

- *Analysis of intraosseous blood samples using an EPOC point of care analyzer during resuscitation, Tallman 2017*
 - Závěr: výsledky srovnatelné pro pH, bikarbonát, sodík, BE, laktát
- *Intraosseous blood samples for point-of-care analysis: agreement between intraosseous and arterial analyses, Jousi et al., 2017*
 - Výsledky: IO vs art. krev - srovnatelné pH, glukóza, laktát. K⁺ lehce vyšší u IO, BE a bikarbonát lehce vyšší, Na a Ca lehce nižší u IO, hodnoty krevních plynů jsou mezi v IO a art. odběrem. Hb, HCT variabilní



Máme se bát komplikací?



- Výchozí podmínky – kritický pacient, PIV nelze, stresová situace
- Četnost zavedení spíše nízká, četnost zavedení na 1 osobu spíše raritní
- Úspěšnost metody 71 – 100%





Complication with Intraosseous Access: Scandinavian Users' Experience

[Peter Hallas](#), MD,* [Mikkel Brabrand](#), MD,[†] and [Lars Folkestad](#), MD[‡]

Complication with Intraosseous Access

Hallas et al

Table. Complication rate with intraosseous access (IO) reported by Scandinavian users - listed by device.

IO-equipment used	All	%	EZ-IO	B.I.G	Cook	Others	p-value*
Cases reported	1,802	100.0	861	255	418	268	
Start complications							
Equipment difficult to assemble	36	2.0	4	21	5	6	< 0.0001
Difficult to identify correct anatomical site	57	3.2	28	17	5	7	0.0013
Bended or broken needle	72	4.0	11	17	20	24	< 0.0001
Patient discomfort / pain	128	7.1	73	13	20	22	0.0663
Difficult to penetrate the periosteum	186	10.3	18	56	51	61	< 0.0001
Difficult to aspirate bone marrow	221	12.3	92	51	38	40	< 0.0001
Complications in use							
Difficult to inject fluid and drugs	133	7.4	59	33	27	14	0.0026
Slow infusion despite use of pressure bag	159	8.8	77	32	34	16	0.0610
Displacement after insertion	153	8.5	47	50	38	18	< 0.0001
Extravasation	66	3.7	25	12	17	12	0.4089
Late complications							
Compartment syndrome	10	0.6	6	1	1	2	0.796
Osteomyelitis	7	0.4	4	1	1	1	1.000
Skin infection	6	0.3	4	1	1	0	0.829



Factors influencing the success and complications of intraosseous access in pediatric patients—a prospective nationwide surveillance study in Germany

Daniel Pfeiffer¹, Martin Olivieri¹, Sebastian Brenner²,
Delphina Gomes¹, Victoria Lieftüchter¹ and
Florian Hoffmann^{1*}

¹Dr. v. Hauner Children's Hospital, Pediatric Intensive Care Unit, Ludwig-Maximilians-University Munich, Munich, Germany, ²Division of Pediatric Intensive Care, Department of Pediatrics, University Hospital Carl Gustav Carus, Dresden, Germany

2023

Results: A total of 417 patients underwent 549 intraosseous access attempts. The overall rates of success and success at the first attempt were 98.3% and 81.9%, respectively. Approximately 63.6% of patients were successfully punctured within 3 min from the time of indication. Approximately 47.7% of IO access attempts required patient resuscitation. Dislocation [OR 17.74 (5.32, 59.15)] and other complications [OR 9.29 (2.65, 32.55)] occurred more frequently in the prehospital environment. A total of 22.7% of patients experienced minor complications, while 2.5% of patients experienced potentially severe complications.

Age structure (n = 417)	Male	Female	n (%)
1–12 months	101 (58.4)	72 (41.6)	173 (41.5)
1–6 years	106 (54.9) ^a	85 (44.0)	193 (46.3)
6–12 years	15 (50.0)	15 (50.0)	30 (7.2)
>12 years	12 (57.1)	9 (42.9)	21 (5.0)
All	234 (56.1)	181 (43.4)	417 (100.0)
Removal of intraosseous needle (n = 307) ^b	n (%)	n (%)	
<1 h	40 (13.0)	209 (68.0)	
1–6 h	169 (55.0)		
6–12 h	50 (16.3)	86 (28.0)	
12–24 h	36 (11.7)		
>24 h	12 (3.9)	12 (3.9)	
Anatomical location of intraosseous access attempt (n = 530)	Individual attempts n (%)	Right side n (%)	Left side n (%)
Tibia	519 (97.9) ^c	265 (51.1)	239 (46.1)
Proximal tibia	509 (96.0) ^c	260 (51.1)	234 (46.0)
Distal tibia	9 (1.7)	4 (44.4)	5 (55.6)
Distal femur	4 (0.8) ^c	2 (50.0)	1 (25.0)
Proximal humerus	6 (1.1) ^c	2 (33.3)	3 (50.0)
Spina iliaca ant. sup.	1 (0.2) ^c	–	–
System used (n = 494)	Individual attempts n (%)	Of which successful (n = 445, 90.1%)	
EZIO semiautomatic drill	460 (93.1)	377 (82.0)	
EZIO drill manual use	5 (1.0)	3 (60.0)	
Cook needle	26 (5.3)	18 (69.2)	
Bone injection gun (BIG)	3 (0.6)	3 (100.0)	

Case Reports

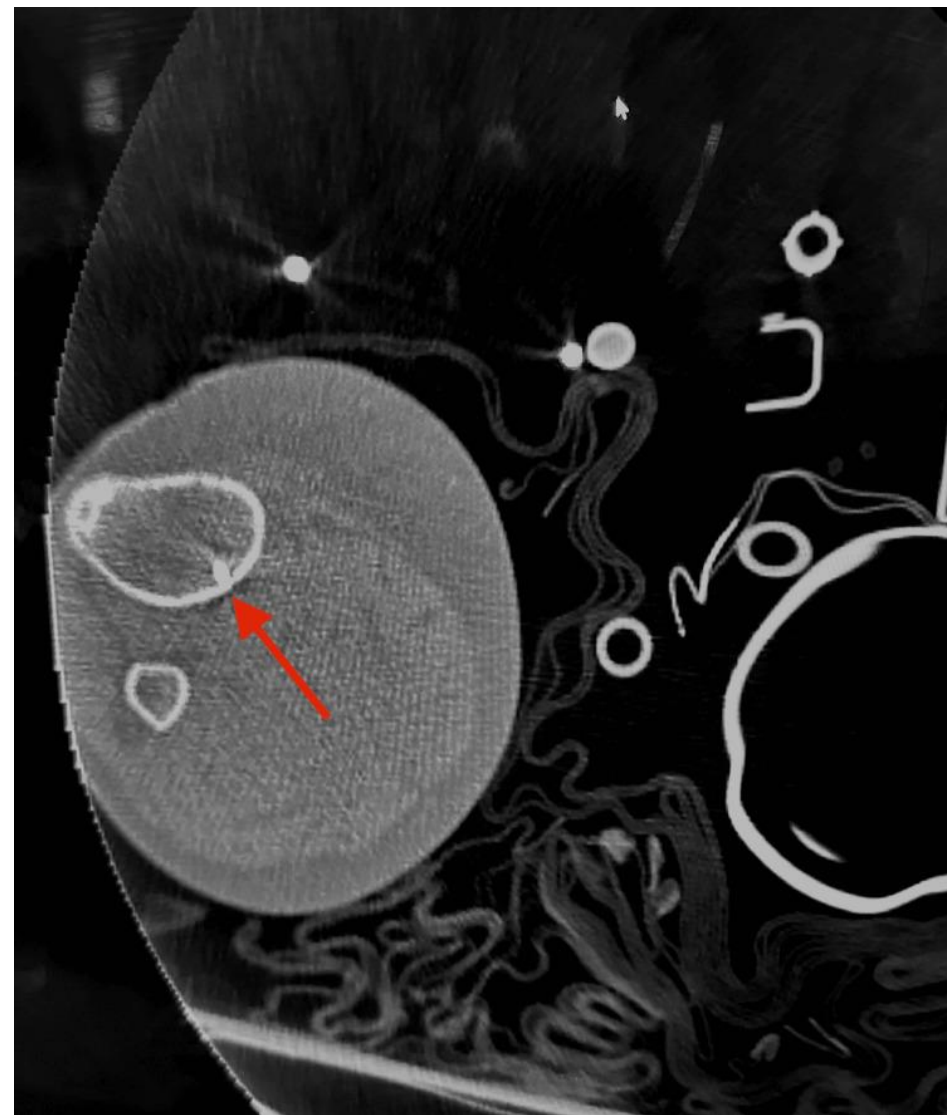
> [Cureus](#). 2023 Dec 9;15(12):e50248. doi: 10.7759/cureus.50248.

eCollection 2023 Dec.

Compartment Syndrome Resulting From Improper Intraosseous Cannulation: A Case Report

Kishan K Desai ^{1 2}, Adam J Mann ^{1 2}, Faris Azar ^{1 2}, Lawrence Lottenberg ^{1 2},
Robert Borrego ^{1 2}

Nesprávně umístěná kanyla pr. Prox. Tibie, st, po
dopravní nehodě, rozvinutí kompartment sy s
nutností fasciotomie ve všech 4 prostorech
Závěr: io je život zachraňující intervence, používat,
ale školit



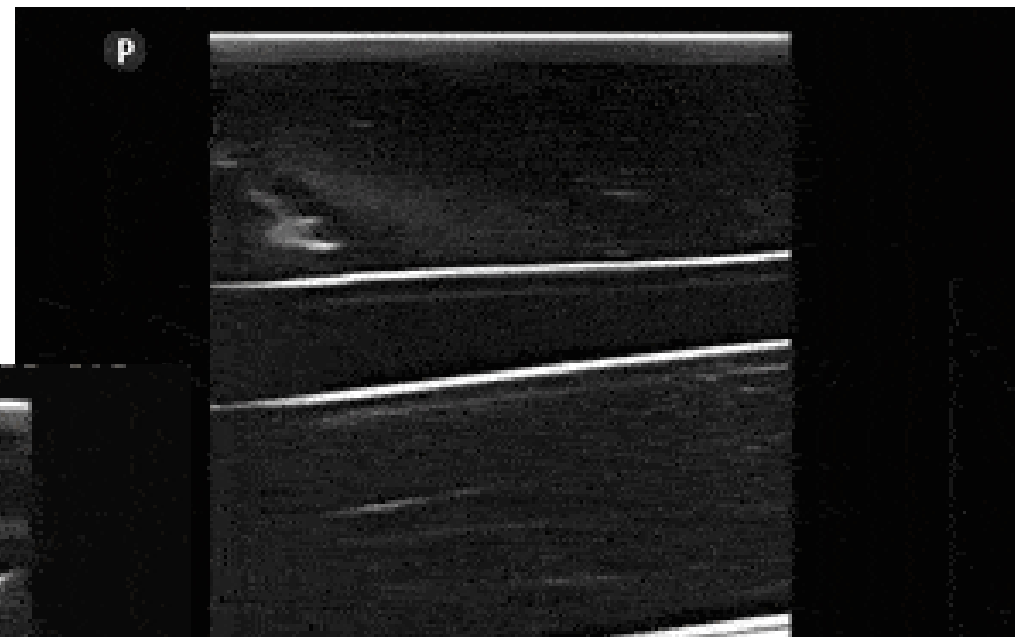
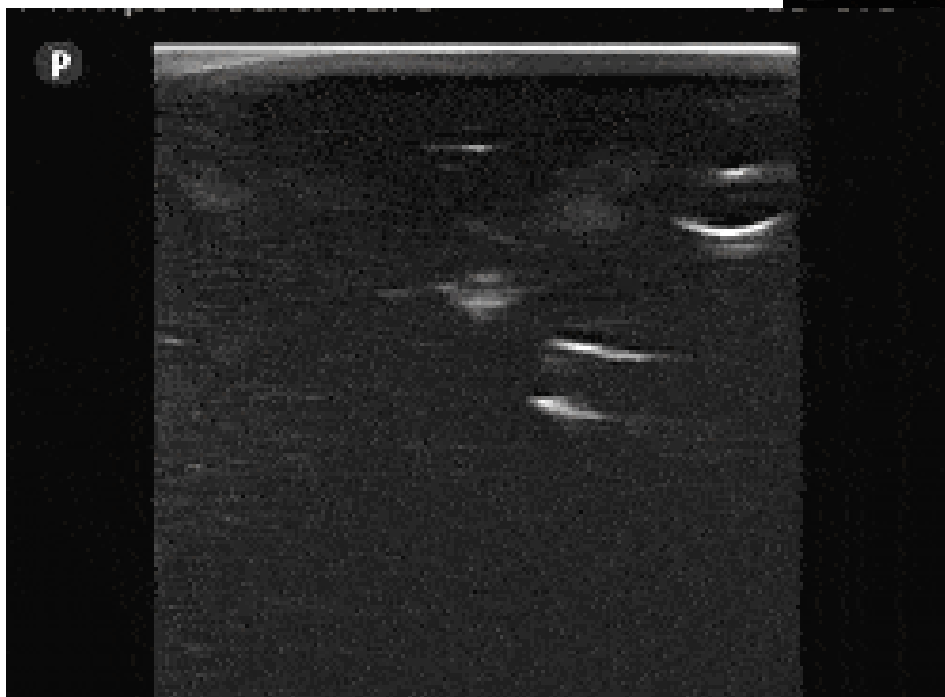
Lze snížit % komplikací?

- Dostupné pomůcky – EZ-IO
- Dostatečné vzdělání a trénink – anatomie, protokoly, simulace = vyhledání místa, technika zavedení, správná fixace
- Dostatečné zkušenosti s metodou – nebát se a používat, je-li indikace
- **Častá kontrola vstupu**



Je pro i.os. vstup ještě místo v době UZ?

- ANO
 - ✓ Čas
 - ✓ Zkušený operátor
 - ✓ Přístroj



<https://www.pocus101.com/ultrasound-guided-peripheral-iv-insertion-placement-and-access-made-easy/>

1. VYHLEDAT MÍSTO VPICHU

- Dle situace
- Dle věku
- EZ-IO zvolit správnou délku jehly

2. PŘÍPRAVA MÍSTA VPICHU

- Dezinfekce
- Asepse





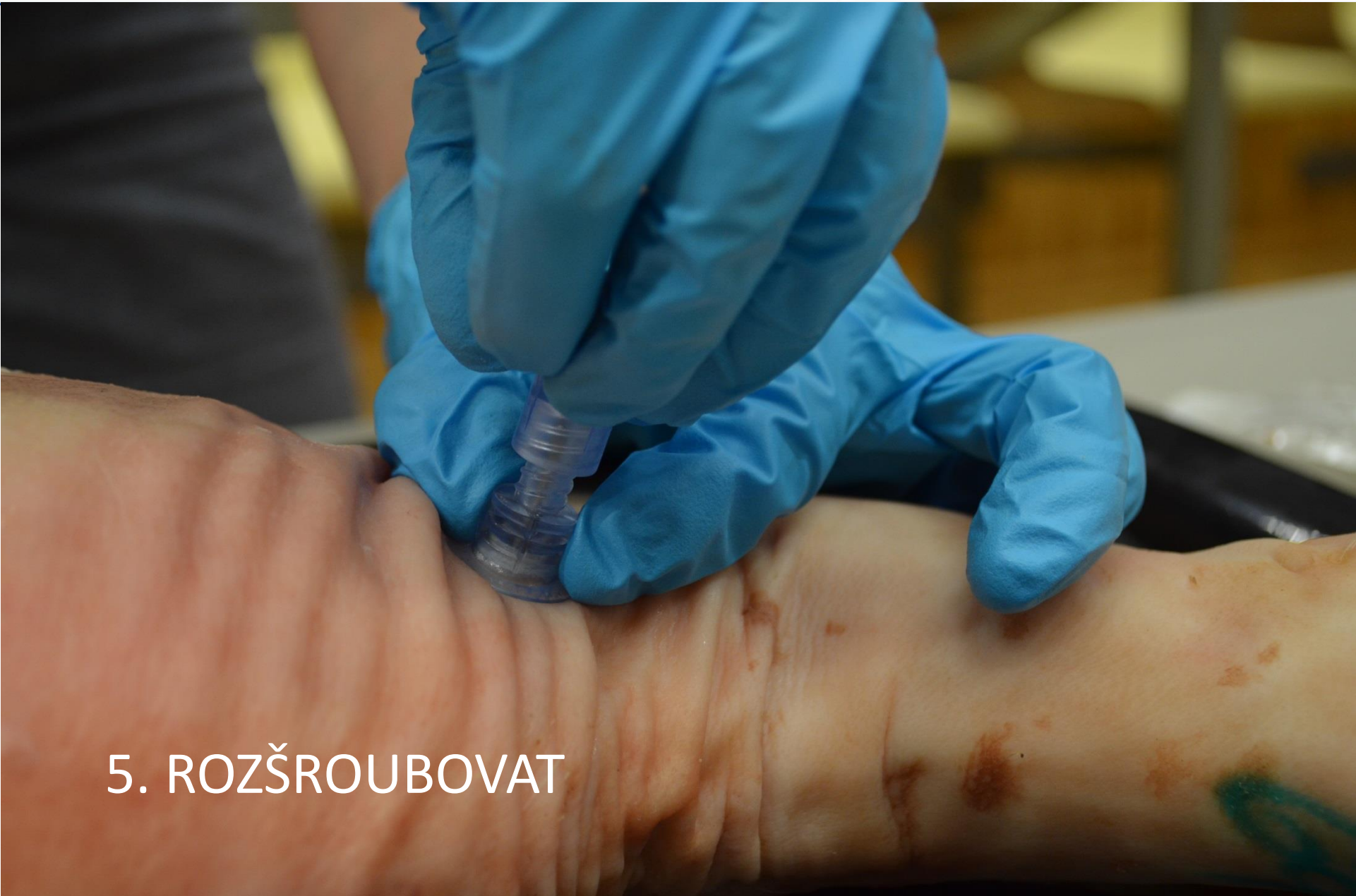
3. PROPÍCHNOUT KŮŽI



4. VRTAT (frézovat)...



..... DO ZTRÁTY ODPORU



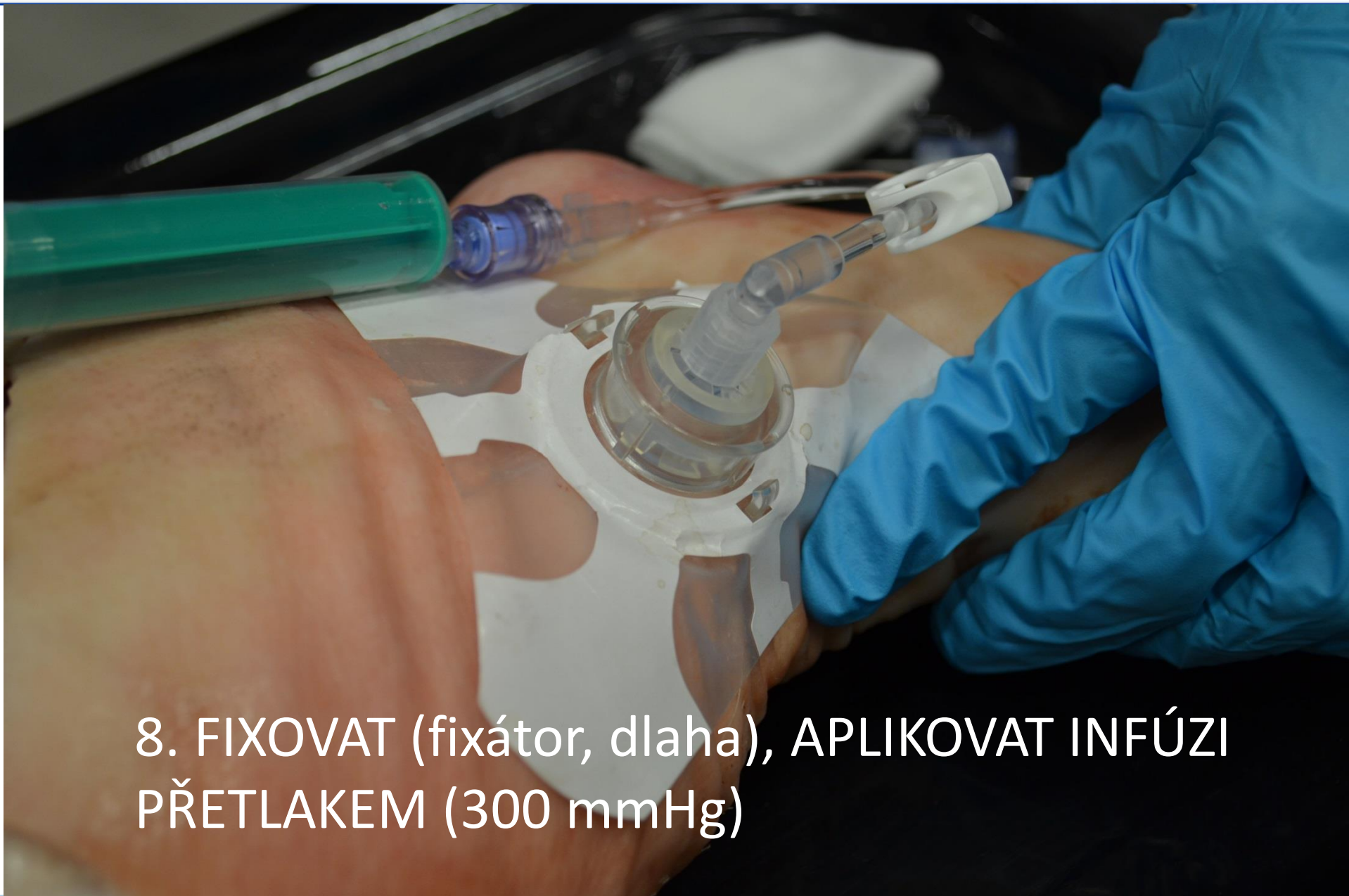
5. ROZŠROUBOVAT



6. ASPIROVAT



7. APLIKOVAT BOLUS!!! (během 5 s 5 - 10 ml
FR, děti 2 – 5 ml)



8. FIXOVAT (fixátor, dlaha), APLIKOVAT INFÚZI
PŘETLAKEM (300 mmHg)

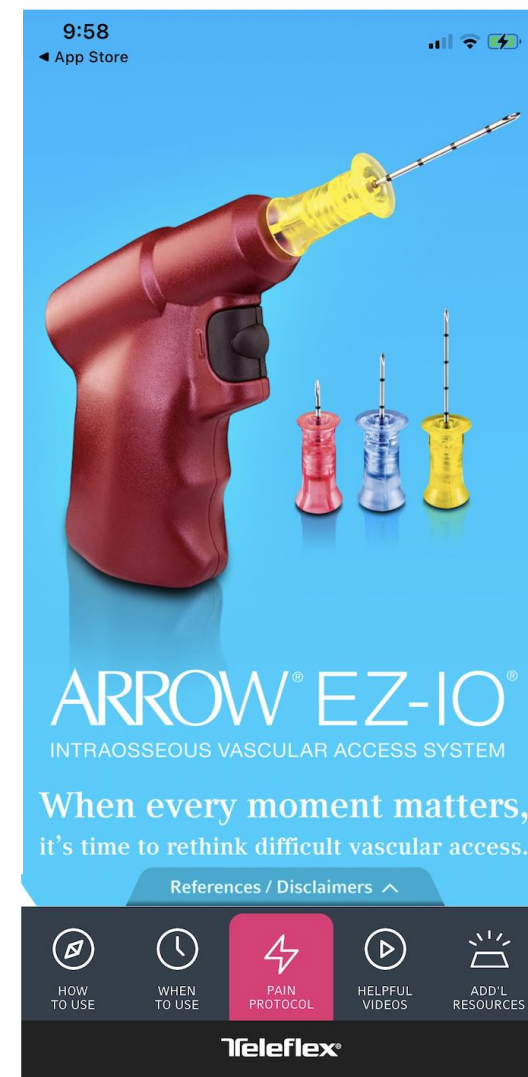
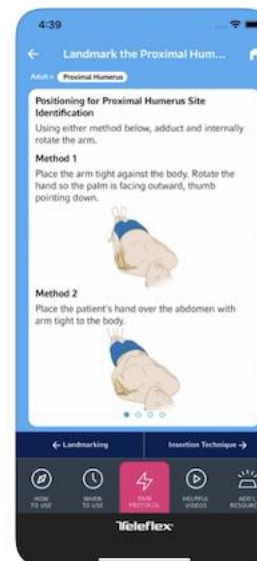


9. ČASTÁ KONTROLA !!!!

**THANK YOU
FOR YOUR ATTENTION**



Teleflex Arrow® EZ-IO® App
Vzdělávání



MUDr. Jana Kubalová
Zdravotnická záchranná služba Zlínského kraje, p.o.
jana.kubalova@zzszk.cz

