VŠEOBECNÁ FAKULTNÍ NEMOCNICE V PRAZE

1. LÉKAŘSKÁ FAKULTA Univerzita Karlova

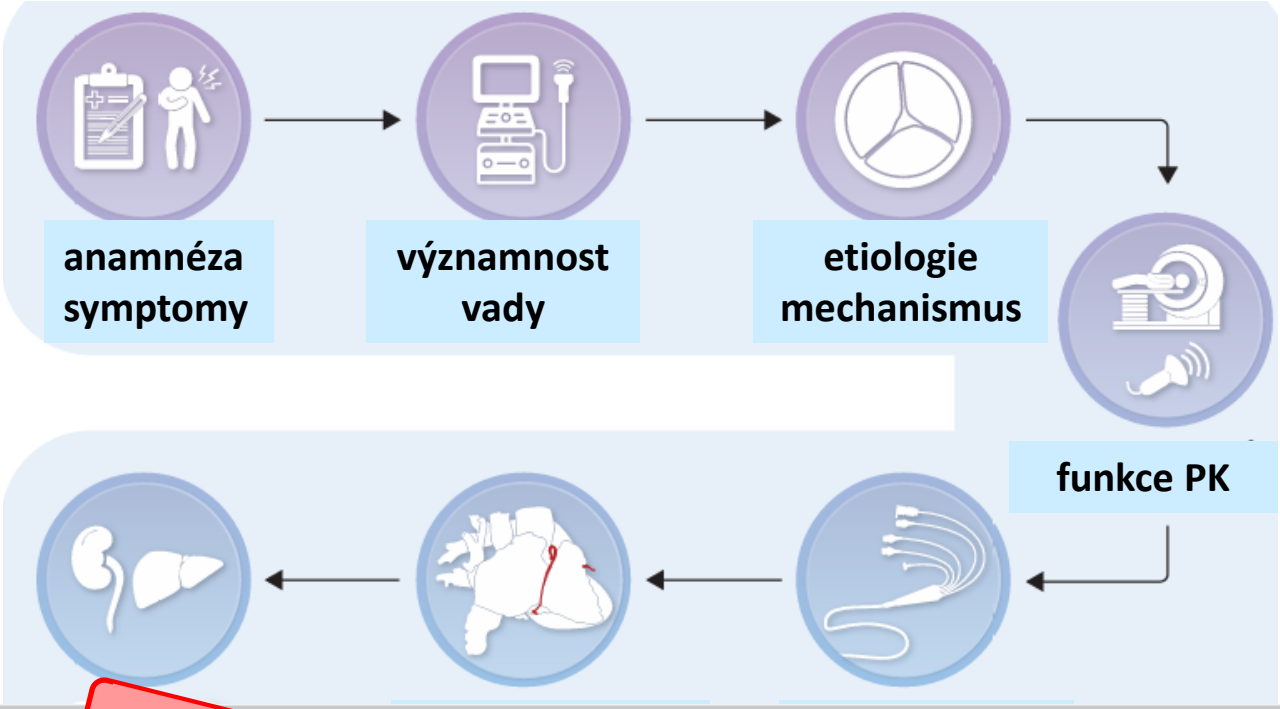
Echokardiografie a trikuspidální vady

Nová ESC doporučení 2025

Zuzana Hlubocká

KOMPLEXNÍ KARDIO VASKULÁRNÍ CENTRUM VFN Praha

Trikuspidální regurgitace – postup step-by-step

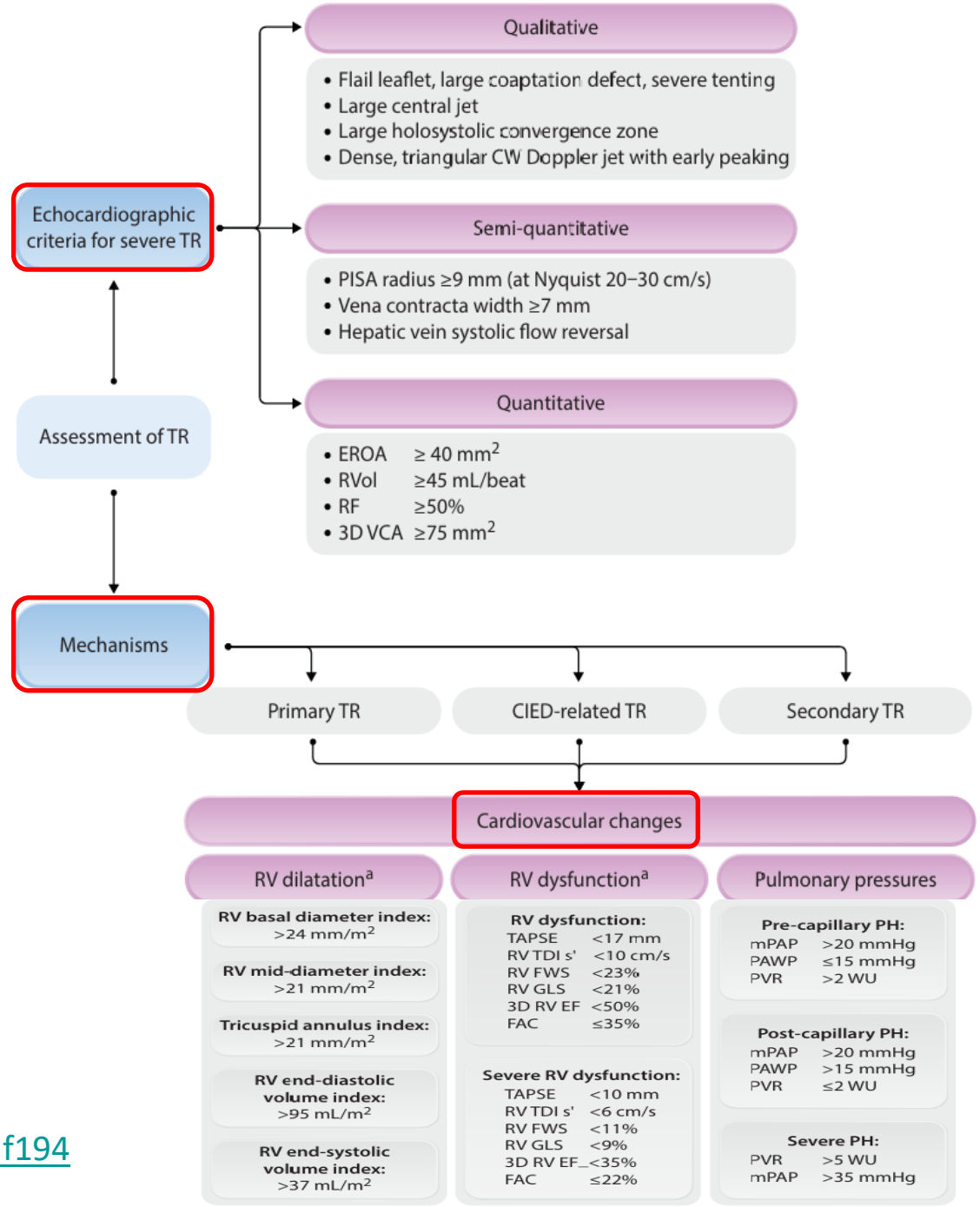


Recommendations	Class	Level
New Careful evaluation of TR aetiology, stage of the disease (i.e. degree of TR severity, RV and LV dysfunction, and PH), patient operative risk, and likelihood of recovery by a multidisciplinary Heart Team is recommended in patients with severe TR prior to intervention.	I	C

Eur Heart J, 2025, 00:0-102., https://doi.org/10.1093/eurheartj/ehaf194

Echokg hodnocení trikuspidální regurgitace

- **Kvantifikace** významnosti regurgitace
- Hodnocení etiologie/**mechanismu** vady
- Posouzení **důsledků** vady na pravé srdce



Eur Heart J, 2025, 00:0-102., https://doi.org/10.1093/eurheartj/ehaf194

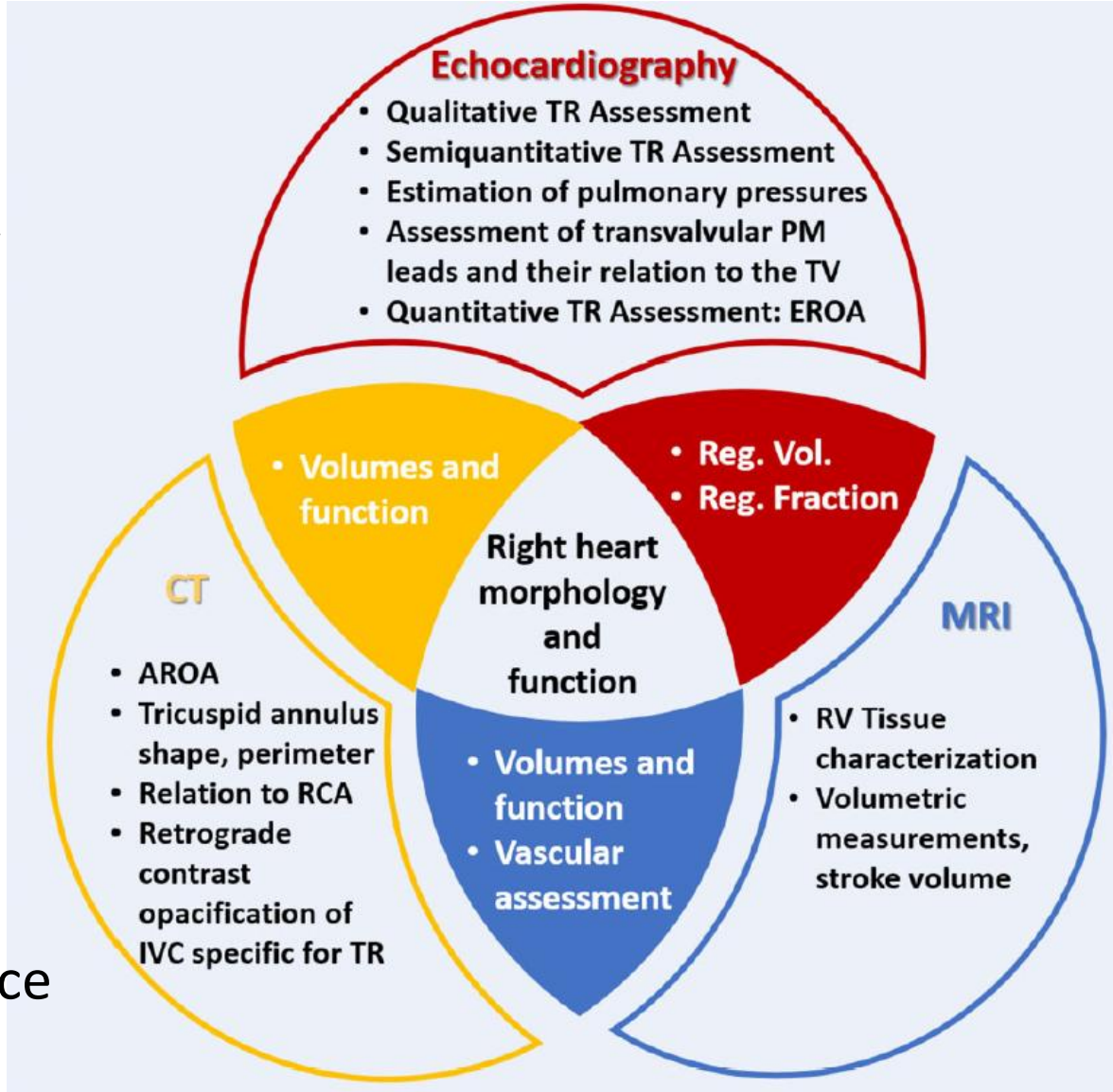
Zobrazovací metody u TR

- **Echokardiografie**
- **kvantifikace, etiologie a mechanismus TR**
- Velikost, objem a funkce PK

- **MRI srdce**
- **objemy a funkce pravé komory**
- kvantifikace TR

- **CT srdce**
- **morfologie anulu, plánování intervencí**
- objemy a funkce PK

+ Katetrizační vyšetření – pravostranná katetrizace



Hahn R. EHJ – CVI 2022 ; 23: 913-929

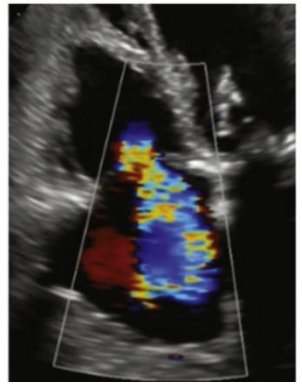
Kvantifikace trikuspidální regurgitace

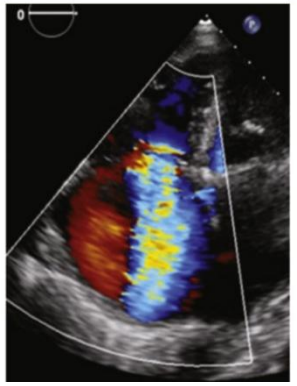
EAE a ASE guidelines

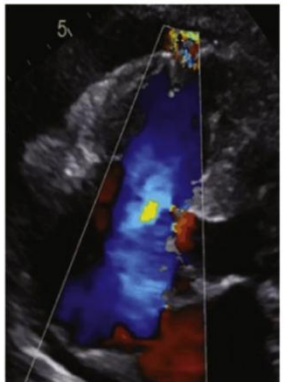
Parameters	Mild	Moderate	Severe
Qualitative			
TV morphology	Mildly abnormal leaflets (e.g. mild rheumatic thickening, limited prolapse)	Moderately abnormal leaflets (e.g. moderate thickening or prolapse)	**Severe valve lesions (e.g. Flail leaflet, ruptured papillary muscle, severe retraction, large perforation or vegetation)**
Interventricular septal motion	Normal	Typically normal	Paradoxical/ volume overload pattern
Color flow TR jet [Note: not recommended for sole grading of severity]	**Small RA penetration or not holosystolic**	Moderate RA penetration or large penetration and late systolic	Deep RA penetration and holosystolic jet
Flow convergence zone	**Not visible, transient or small**	Intermediate in size and duration	**Large throughout systole**
CW signal TR jet	Faint/parabolic or partial contour	Dense, variable contour	Dense, triangular with early peaking contour (peak <2 m/s in very severe TR)
IVC diameter	Normal	2.1 -2.5 cm	>2.5 cm
Semi-quantitative			
Color flow jet area (cm^2) [Central Jet][a]	<5	5-10	> 10
Color jet area:RA area (%)	10-20	10-33	>33
Vena contracta (cm)	<0.3	<0.6	**≥ 0.7**
PISA Radius (cm)[b]	≤0.5	0.6-0.9	> 0. 9
Hepatic vein flow	Systolic dominance	Systolic blunting[c]	**Systolic flow reversal**
Tricuspid inflow	E-wave < 1 m/sec or A-wave dominant	Variable	E-wave ≥1.0 m/sec
Quantitative			
EROA (mm^2) [by PISA]	<20	20-39[d]	≥40
EROA (mm^2) [by 3D]	Unknown	Unknown	>75
Regurgitant volume(mL) [by PISA]	<30	30-45[d]	≥45
RV and RA size	Usually normal	Usually normal or mild dilatation	Usually dilated[e]

Rozšířená klasifikace TR

Variable	Severe	Massive	Torrential
VC (biplane)	7–13 mm	14–20 mm	≥21 mm
EROA (PISA)	40–59 mm^2	60–79 mm^2	≥80 mm^2
3D VCA or quantitative EROA[a]	75–94 mm^2	95–114 mm^2	≥115 mm^2







Zoghbi WA et al., JASE 2017;30

Lancellotti P. Eur Heart J Cardiovasc Imaging 2022; 23: e171-232

Hahn R.T., Eur Heart J Cardiovasc Imaging 2017, 18: 1342-43

Echokg parametry významné trikuspidální regurgitace

Qualitative

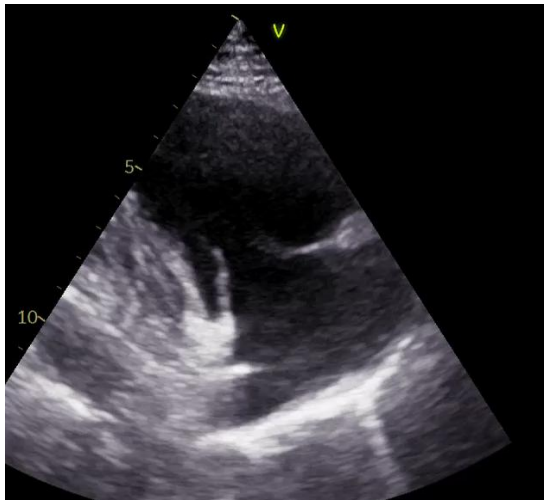
- Flail leaflet, large coaptation defect, severe tenting
- Large central jet
- Large holosystolic convergence zone
- Dense, triangular CW Doppler jet with early peaking

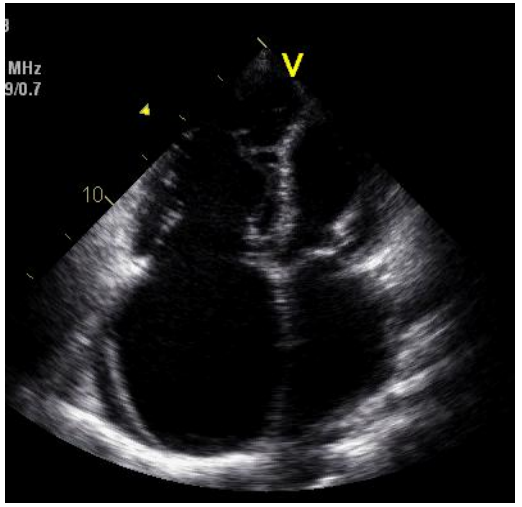
Semi-quantitative

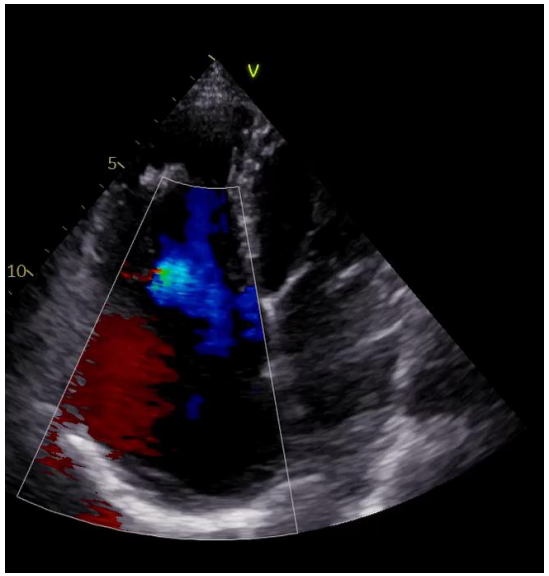
- PISA radius ≥9 mm (at Nyquist 20–30 cm/s)
- Vena contracta width ≥7 mm
- Hepatic vein systolic flow reversal

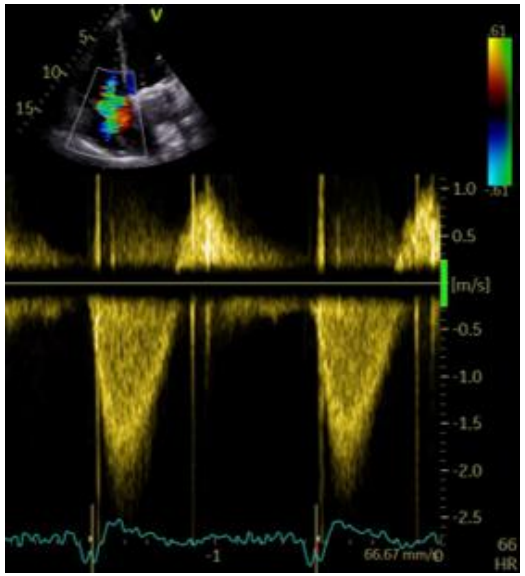
Quantitative

- EROA ≥ 40 mm^2
- RVol ≥45 mL/beat
- RF ≥50%
- 3D VCA ≥75 mm^2









Eur Heart J, 2025, 00:0-102., https://doi.org/10.1093/eurheartj/ehaf194

Obrazový archiv VFN, Praha

Kvantifikace trikuspidální regurgitace

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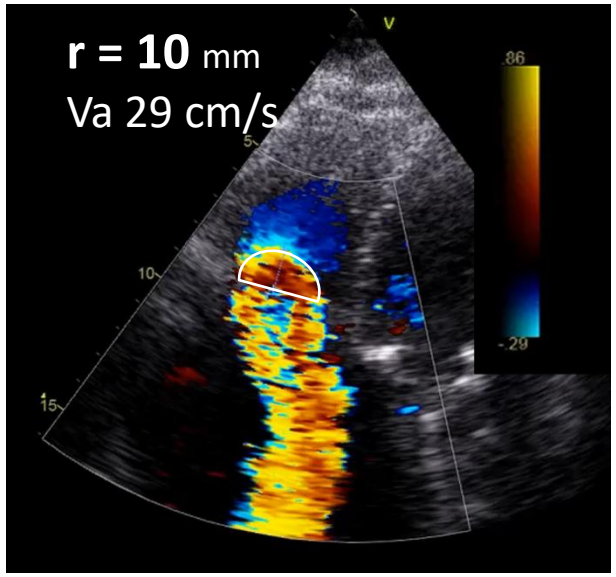

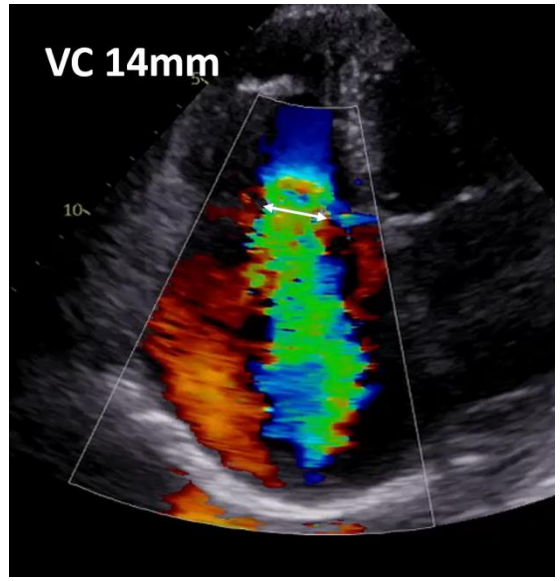

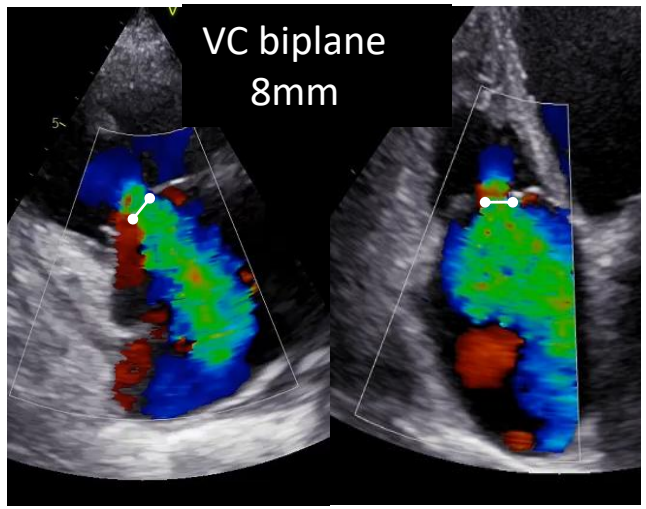

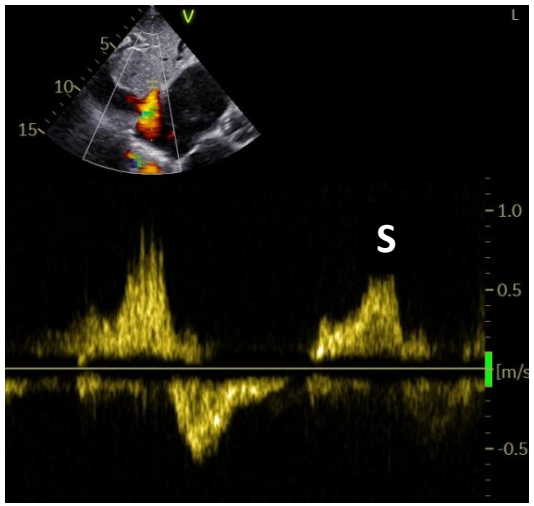

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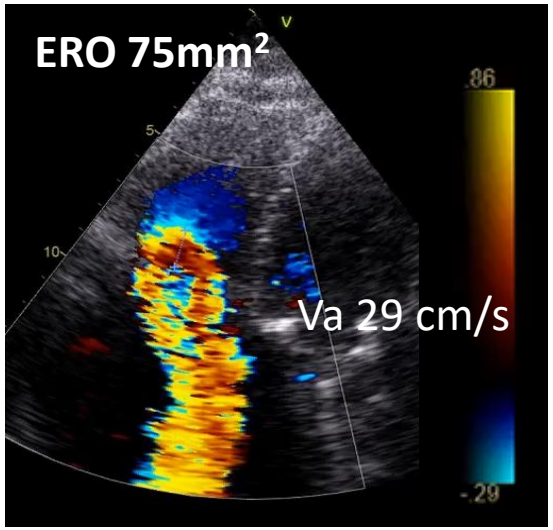

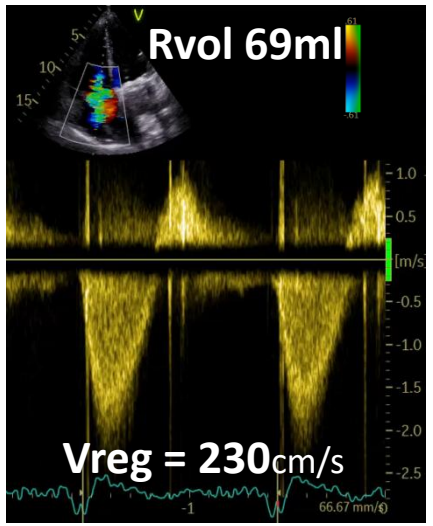

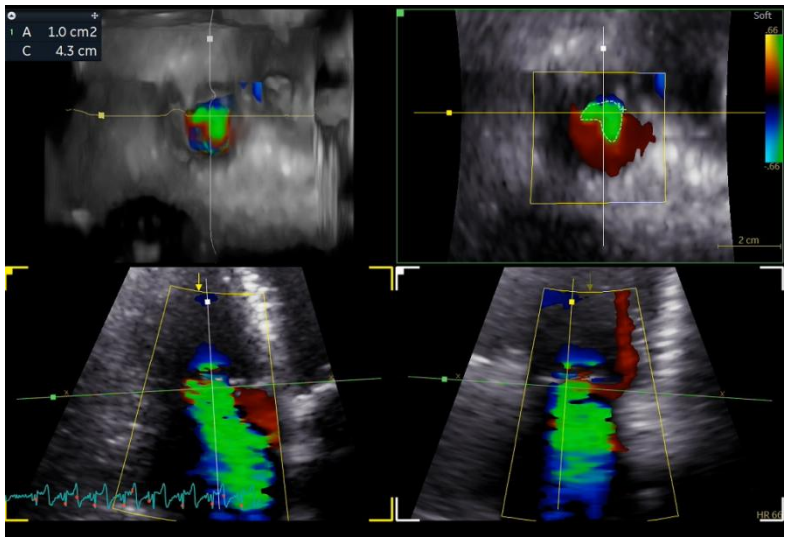

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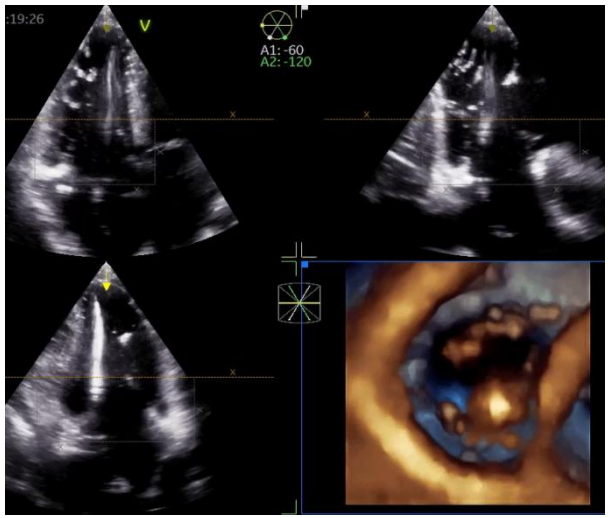
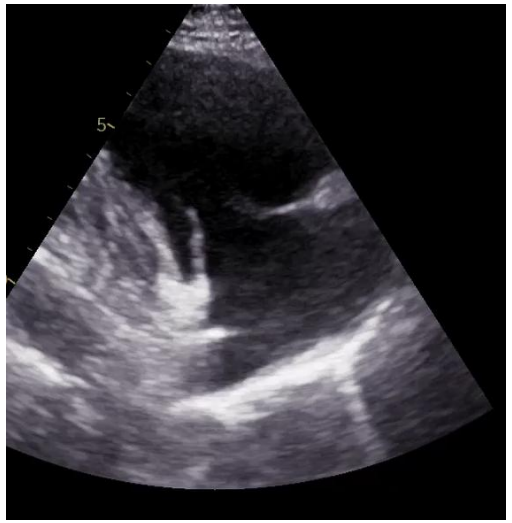
Obrazový archiv VFN, Praha

Hodnocení mechanismu TR

Sekundární/funkční (88%) | **CIED TR** | **Primární/organická (8%)**

Atriální | **Ventrikulární**





Fibrilace síní

Plicní hypertenze
- při vadách a onem. levého srdce
- arteriální
- plicní nemoci, embolie

Ebsteinova anomálie

Infekční endokarditida

Prolaps

Karcinoid, trauma

Hahn R. EHJ – CVI 2022 ; 23: 913-929

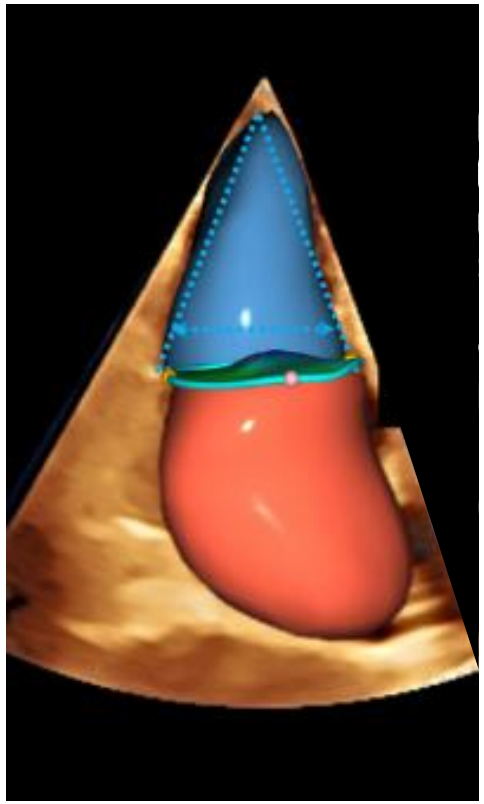
Obrázky – obrazový archiv VFN

Typy sekundární TR

kónická PK
dilatace bazálně

dilatace anulu

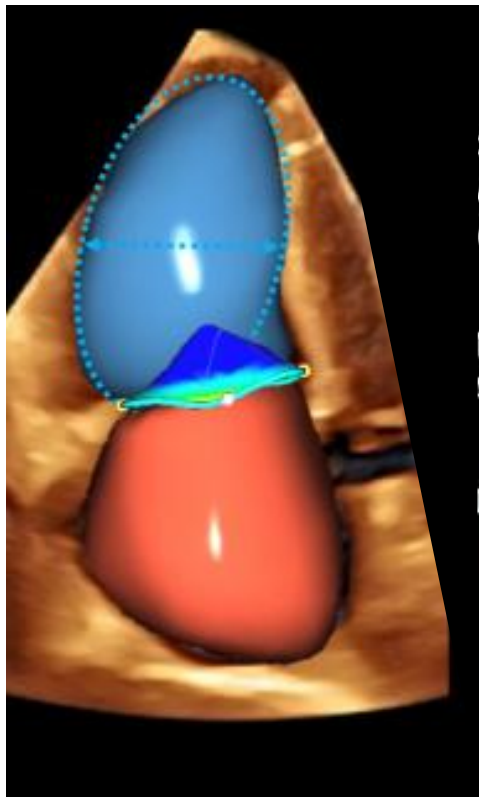
dilatace síně



sférická PK
dilatace a prodloužení PK

tenting cípů
menší dilatace anulu

dilatace síně



Atriální sekundární TR

- bez významné plicní hypertenze
- typicky přítomna **fibrilace síní**

Ventrikulární sekundární TR

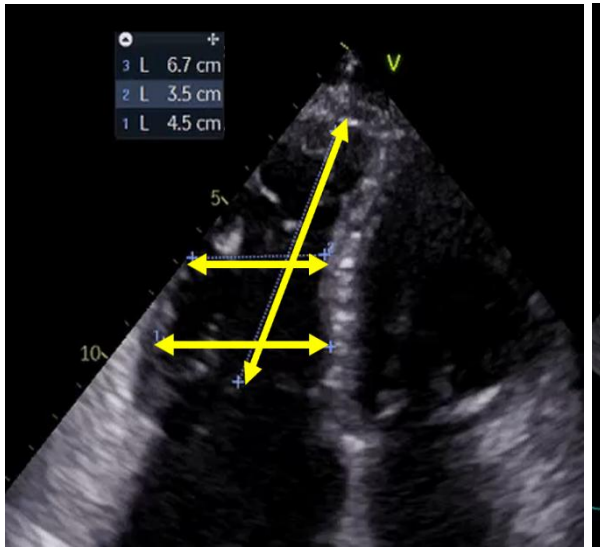
- s plicní hypertenzí

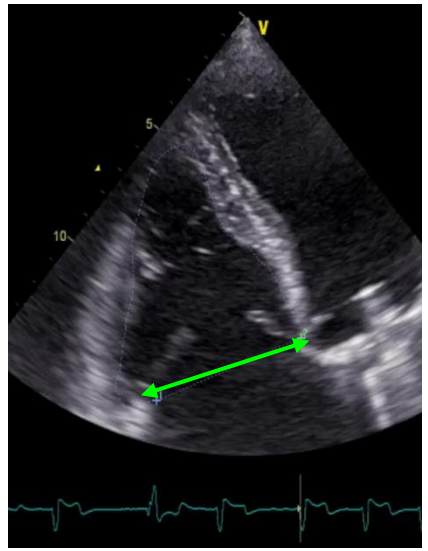
Badano L., J Am Soc Echocardiogr 2024; 37:1083-1102

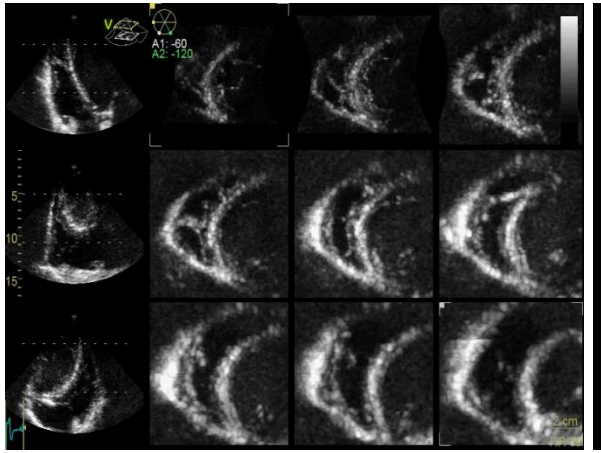
Hodnocení důsledků TR na pravé srdce

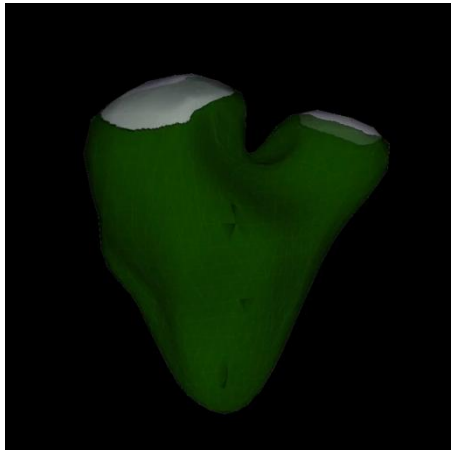
Cardiovascular changes

RV dilatation[a]	RV dysfunction[a]	Pulmonary pressures
RV basal diameter index: >24 mm/m^2	**RV dysfunction:** TAPSE <17 mm; RV TDI s' <10 cm/s; RV FWS <23%; RV GLS <21%; 3D RV EF <50%; FAC ≤35%	**Pre-capillary PH:** mPAP >20 mmHg; PAWP ≤15 mmHg; PVR >2 WU
RV mid-diameter index: >21 mm/m^2	**Severe RV dysfunction:** TAPSE <10 mm; RV TDI s' <6 cm/s; RV FWS <11%; RV GLS <9%; 3D RV EF <35%; FAC ≤22%	**Post-capillary PH:** mPAP >20 mmHg; PAWP >15 mmHg; PVR ≤2 WU
Tricuspid annulus index: >21 mm/m^2		**Severe PH:** PVR >5 WU; mPAP >35 mmHg
RV end-diastolic volume index: >95 mL/m^2		
RV end-systolic volume index: >37 mL/m^2		









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Obrazový archiv VFN, Praha

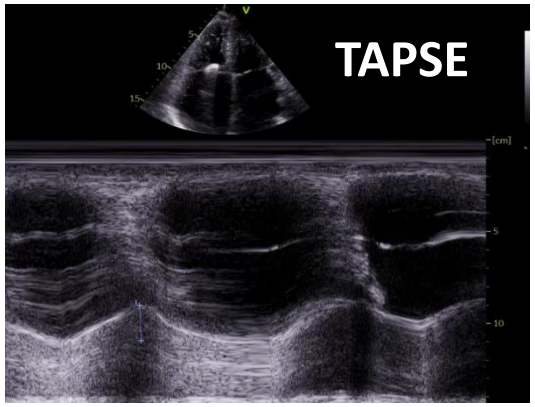
Hodnocení funkce pravé komory

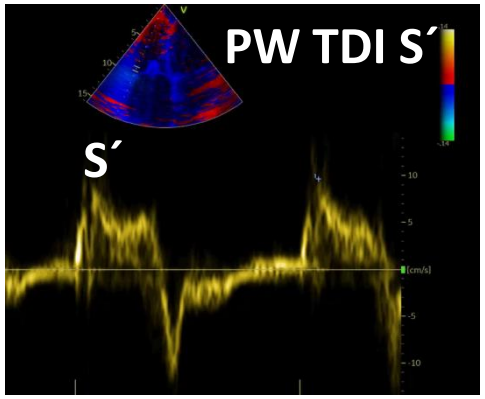
RV dysfunction:

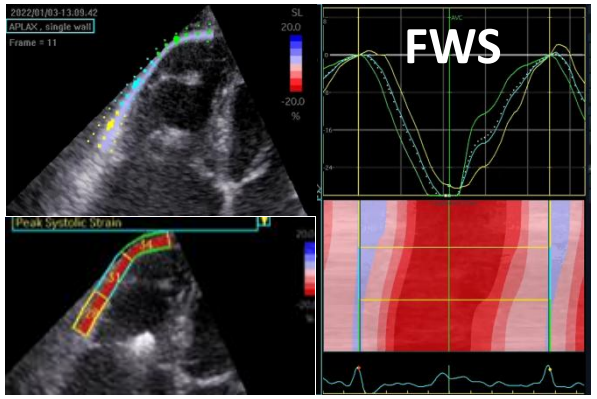
TAPSE	<17 mm
RV TDI s'	<10 cm/s
RV FWS	<23%
RV GLS	<21%
3D RV EF	<50%
FAC	≤35%

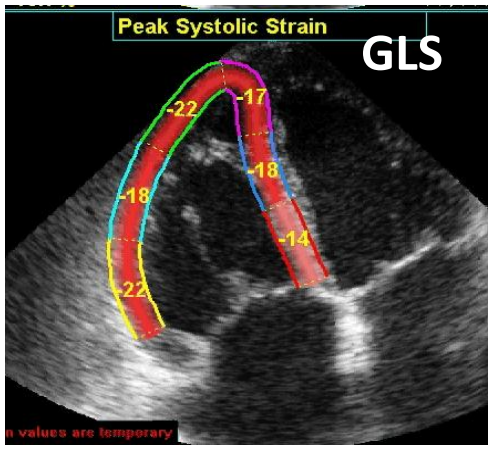
Severe RV dysfunction:

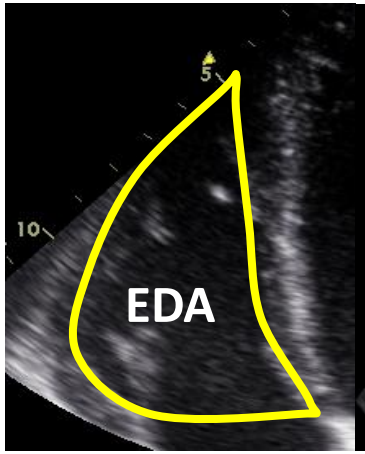
TAPSE	<10 mm
RV TDI s'	<6 cm/s
RV FWS	<11%
RV GLS	<9%
3D RV EF	<35%
FAC	≤22%

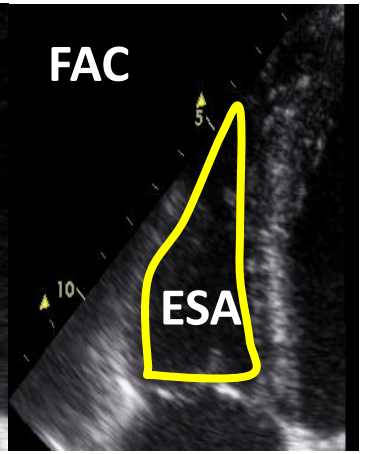


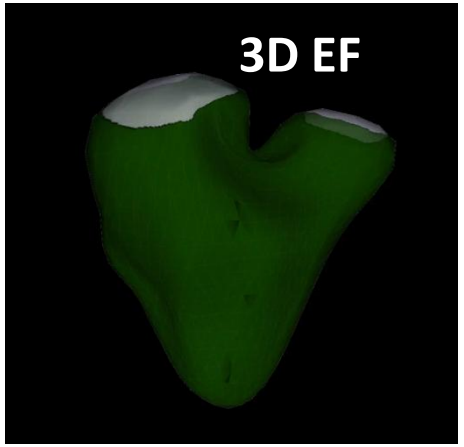












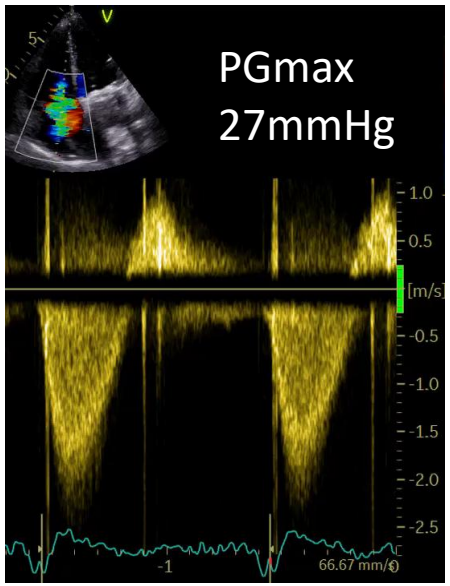
Při významné TR echokg parametry nadhodnocují funkci pravé komory

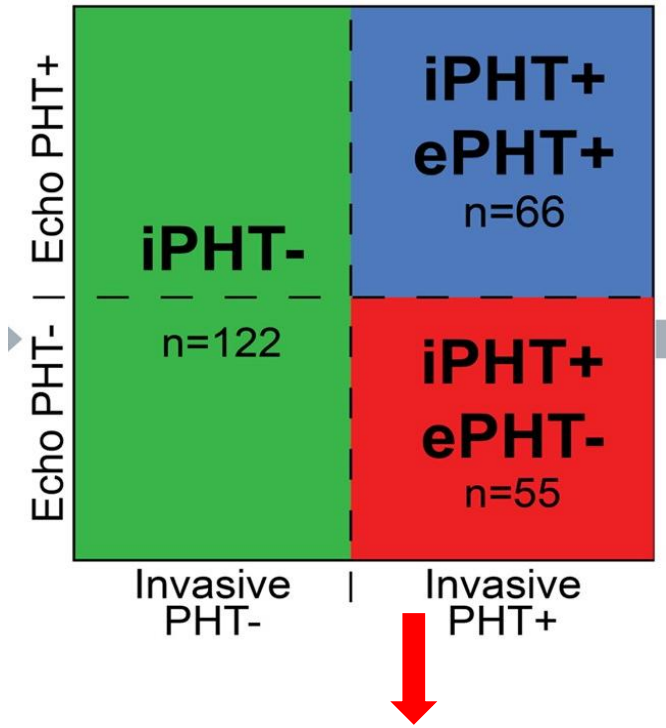
Eur Heart J, 2025, 00:0-102., https://doi.org/10.1093/eurheartj/ehaf194

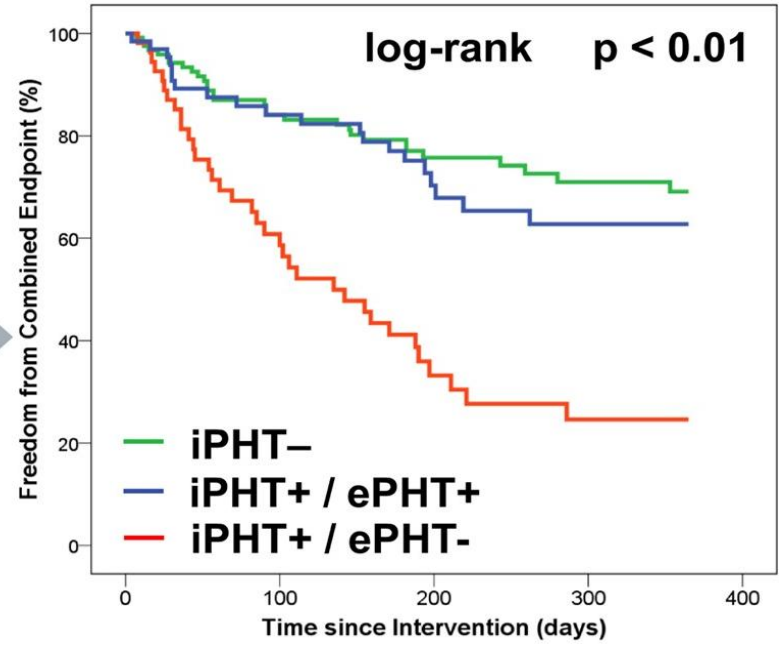
Obrazový archiv VFN, Praha

Plicní hypertenze u nemocných s významnou TR

- 243 pacientů **s významnou TR**, **plicní hypertenze echokg a pravostrannou katetrizací**
- jen 55% pacientů s invazivně PASP > 50mmHg mělo echokg plicní hypertenzi (PASP > 50mHg)
- **iPHT+/ePHT- mají nejhorší prognózu**







Echokg hodnocení plicní hypertenze má u významné TR omezený význam

Lurz P. et al. EHJ 2020; 41/(8): 2785-2795

Hodnocení plicní hypertenze

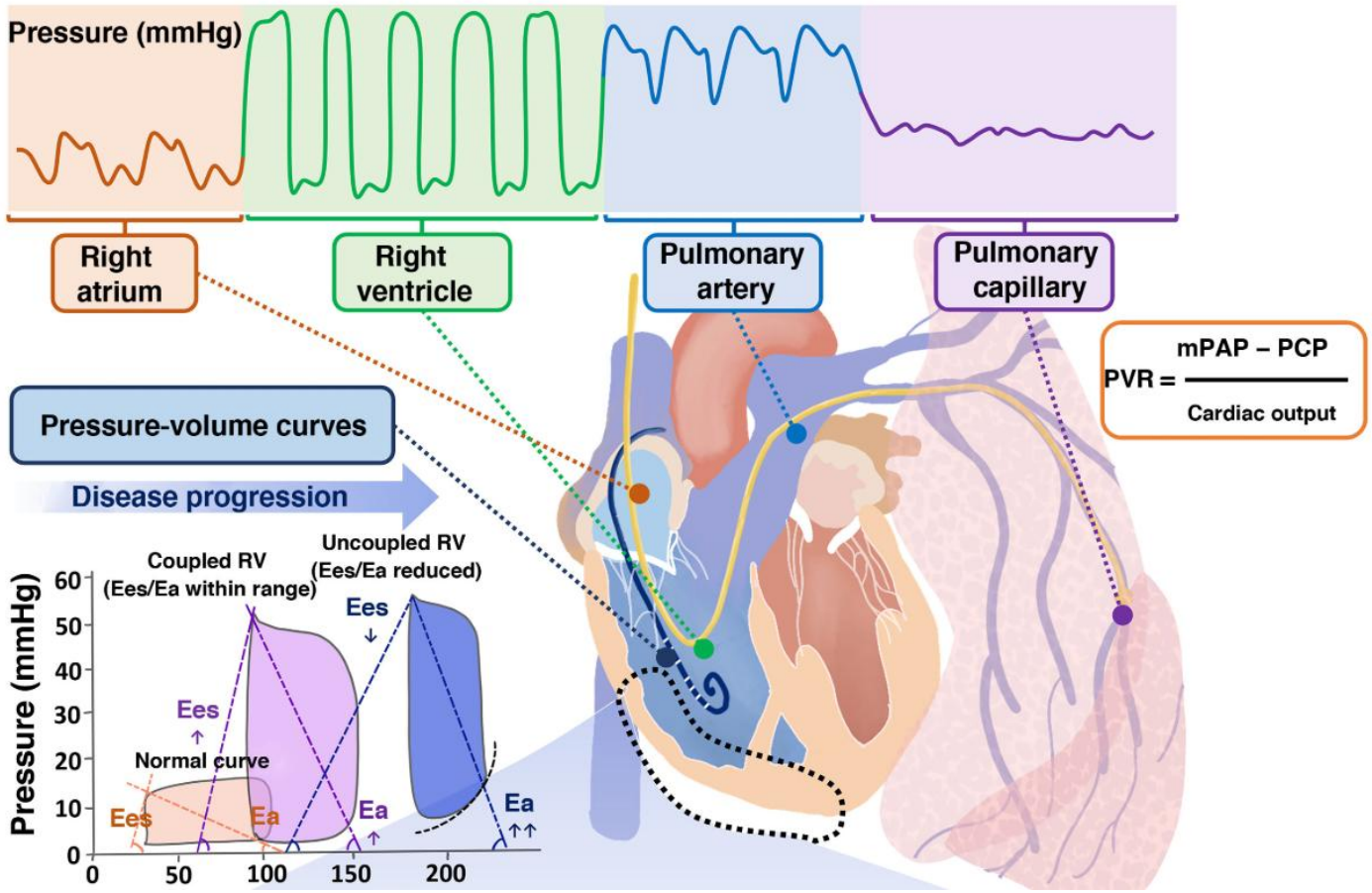
➡ Pravostranná katetrizace doporučena u významné TR zvažované k intervenci

Pulmonary pressures

Pre-capillary PH:
mPAP >20 mmHg
PAWP ≤15 mmHg
PVR >2 WU

Post-capillary PH:
mPAP >20 mmHg
PAWP >15 mmHg
PVR ≤2 WU

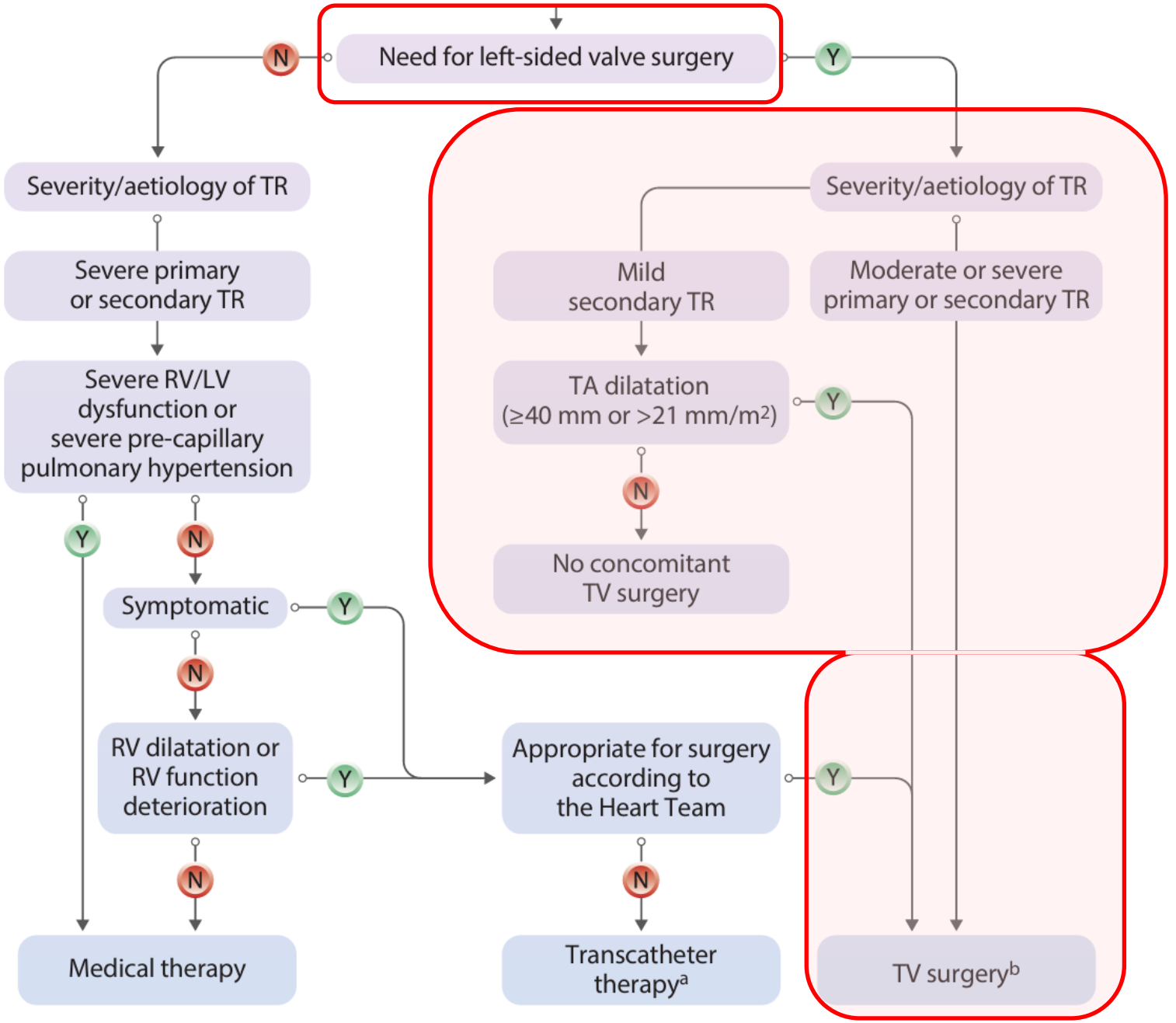
Severe PH:
PVR >5 WU
mPAP >35 mmHg



Eur Heart J, 2025, 00:0-102., https://doi.org/10.1093/eurheartj/ehaf194

Real C et al. Rev Esp Cardiol 2024; 77(11):957-970

Indikace k intervenci u pacientů s TR



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Indikace k intervenci TR – nemocní indikovaní k operaci levostranné vady

Recommendations	Class	Level
Patients with tricuspid regurgitation and left-sided valvular heart disease requiring surgery		
Concomitant TV surgery is recommended in patients with severe primary or secondary TR.	I	B
Concomitant TV repair should be considered in patients with moderate primary or secondary TR, to avoid progression of TR and RV remodelling. REV.	IIa	B
Concomitant TV repair may be considered in selected patients with mild secondary TR and tricuspid annulus dilatation (≥40 mm or >21 mm/m^2), to avoid progression of TR and RV remodelling. REV.	IIb	B

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Eur Heart J, 2025, 00:0-102., https://doi.org/10.1093/eurheartj/ehaf194

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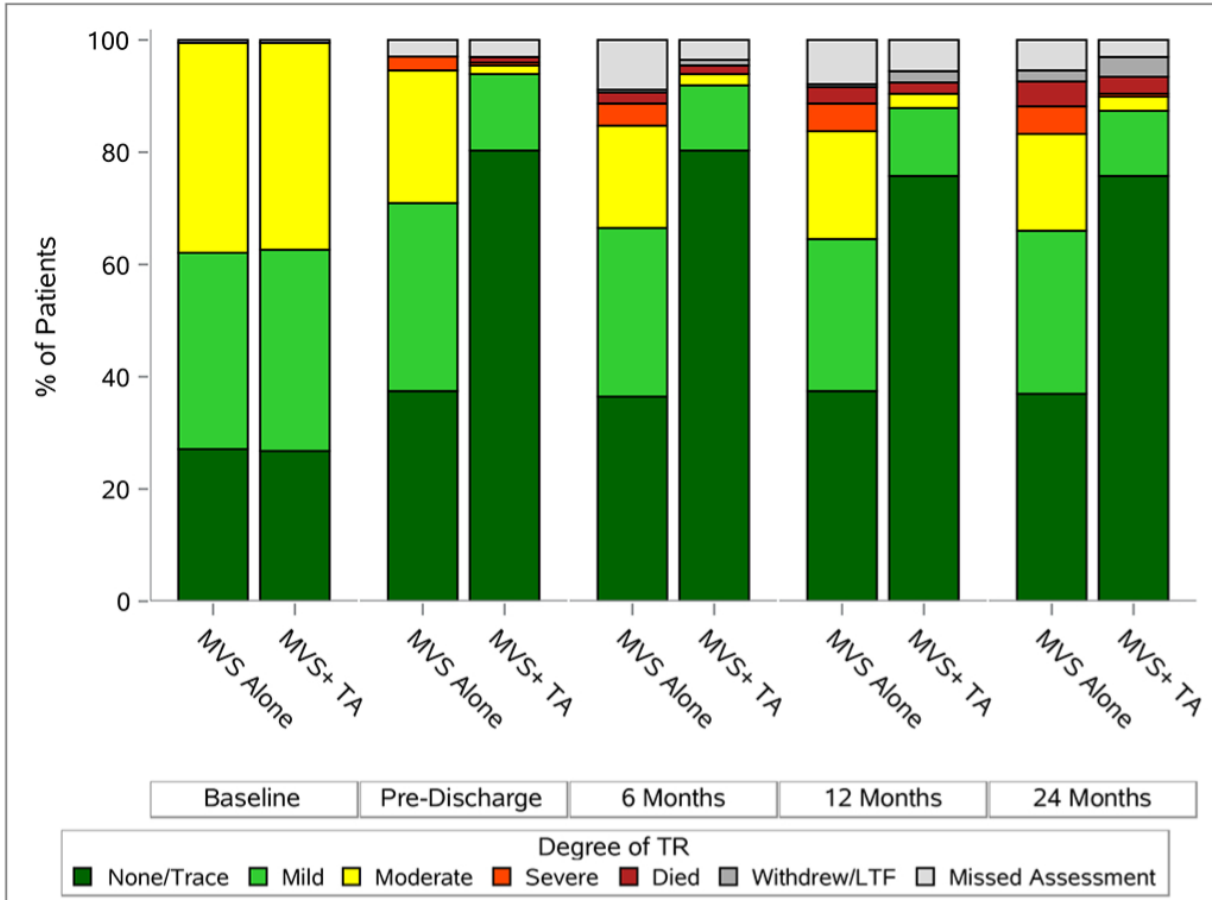
TR u nemocných s významnou levostrannou vadou

- **k progresi TR docházelo u střední TR, ne u lehké TR**
- Trikuspidální anuloplastika spojena s častou **implantací trvalé KS (14%** vs. 2,5%)

Randomized Controlled Trial > N Engl J Med. 2022 Jan 27;386(4):327-339.
doi: 10.1056/NEJMoa2115961. Epub 2021 Nov 13.

Concomitant Tricuspid Repair in Patients with Degenerative Mitral Regurgitation

All Patients	MVS Alone (N=203)	MVS + TA (N=198)	Relative Risk (95% CI)	P-value
Primary Endpoint				
Imputed - % (95% CI)	10.2 (6.0, 14.5)	3.9 (1.1, 6.7)	0.37 (0.16, 0.86)	0.02
Observed	20/188 (10.6)	7/185 (3.8)	0.35 (0.15, 0.81)	-
Died within 2 Years	9/199 (4.5)	6/190 (3.2)	0.69 (0.25, 1.88)	-
TV Operation within 2 Years	0/190 (0.0)	0/184 (0.0)	-	-
Progression of TR at 2 Years	11/179 (6.1)	1/179 (0.6)	0.09 (0.01, 0.69)	-



Gammie et al., NEJM 2022

Ailawadi et al., J Thorac Cardiovasc Surg 2000

Trikuspidální anuloplastika při operaci levostranné vady

Factors favouring concomitant TV surgery	Factors not favouring concomitant TV surgery
TR moderate or more	TR mild
Tricuspid annular dilatation	No tricuspid annular dilatation
Chronic AF	First-degree atrioventricular block, pre-existing left bundle branch block
Significant RA dilatation	Normal RA dimension
RV dilatation or (non-severe) dysfunction	Normal RV function and diameter
Presence of (non-severe) TV leaflet tethering	Absence of TV leaflet tethering
Pulmonary hypertension SPAP ≥50 mmHg	Normal pulmonary pressures
Reversible renal and liver dysfunction	No other comorbidities

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Eur Heart J, 2025, 00:0-102., https://doi.org/10.1093/eurheartj/ehaf194

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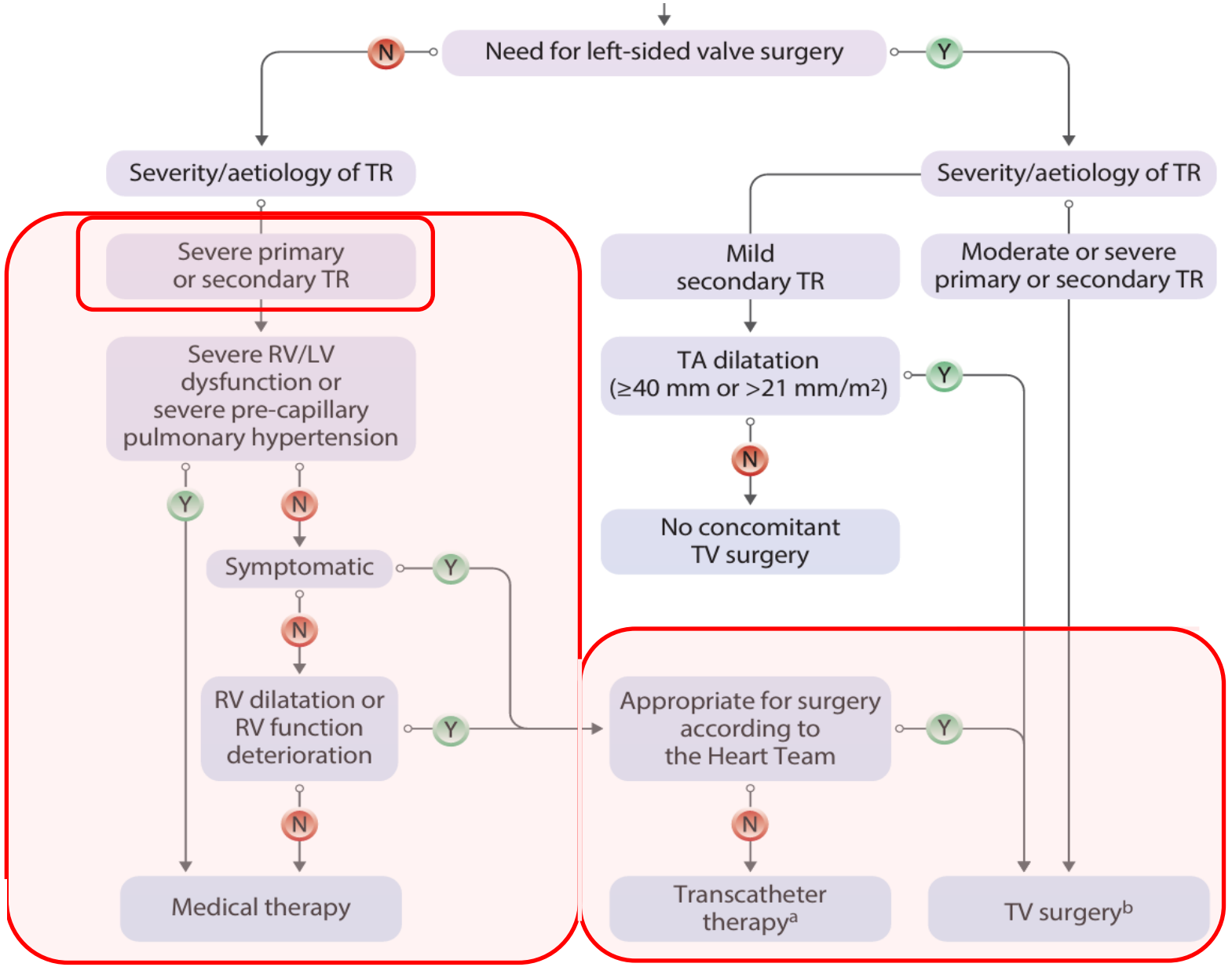
Indikace k intervenci u pacientů s TR



Eur Heart J, 2025, 00:0-102., https://doi.org/10.1093/eurheartj/ehaf194

Indikace k operaci u významné izolované TR

Recommendations	Class	Level
Patients with severe tricuspid regurgitation without left-sided valvular heart disease requiring surgery		
TV surgery is recommended in symptomatic patients with severe primary TR without severe RV dysfunction or severe PH.	I	C
TV surgery should be considered in asymptomatic patients with severe primary TR who have RV dilatation/RV function deterioration, but without severe LV/RV dysfunction or severe PH.	IIa	C
TV surgery should be considered in patients with severe secondary TR who are symptomatic or have RV dilatation/RV function deterioration, but without severe LV/RV dysfunction or PH.	IIa	B

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Eur Heart J, 2025, 00:0-102., https://doi.org/10.1093/eurheartj/ehaf194

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Indikace ke katetrizační intervenci trikuspidální regurgitace

Recommendations	Class	Level
Patients with severe tricuspid regurgitation without left-sided valvular heart disease requiring surgery		
Transcatheter TV treatment should be considered to improve quality of life and RV remodelling in high-risk patients with symptomatic severe TR despite optimal medical therapy in the absence of severe RV dysfunction or pre-capillary PH.	IIa	A

Podpořeno výsledky 3 randomizovaných studií, multicentrických registrů a dalších studií

Eur Heart J, 2025, 00:0-102., https://doi.org/10.1093/eurheartj/ehaf194

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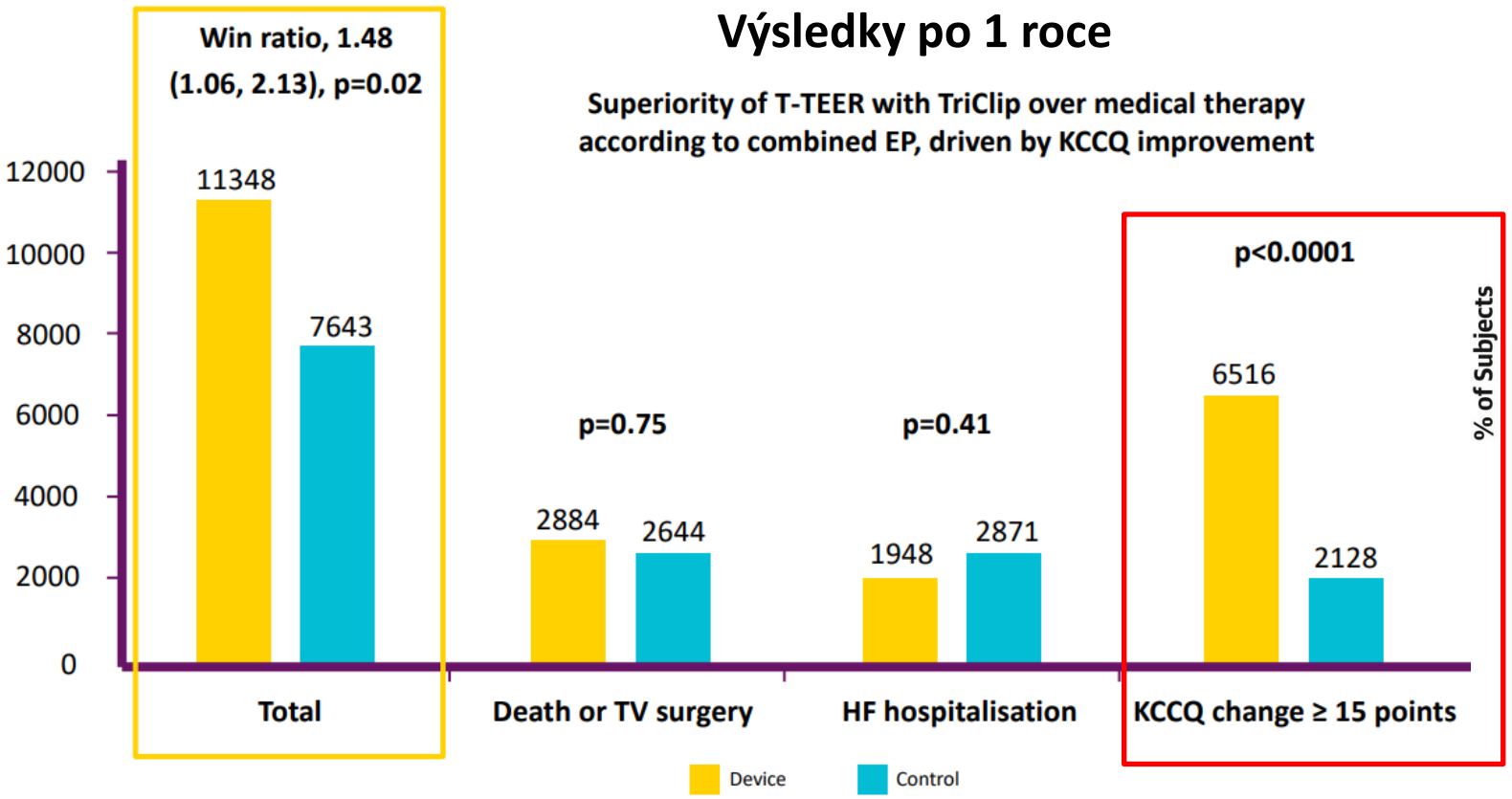
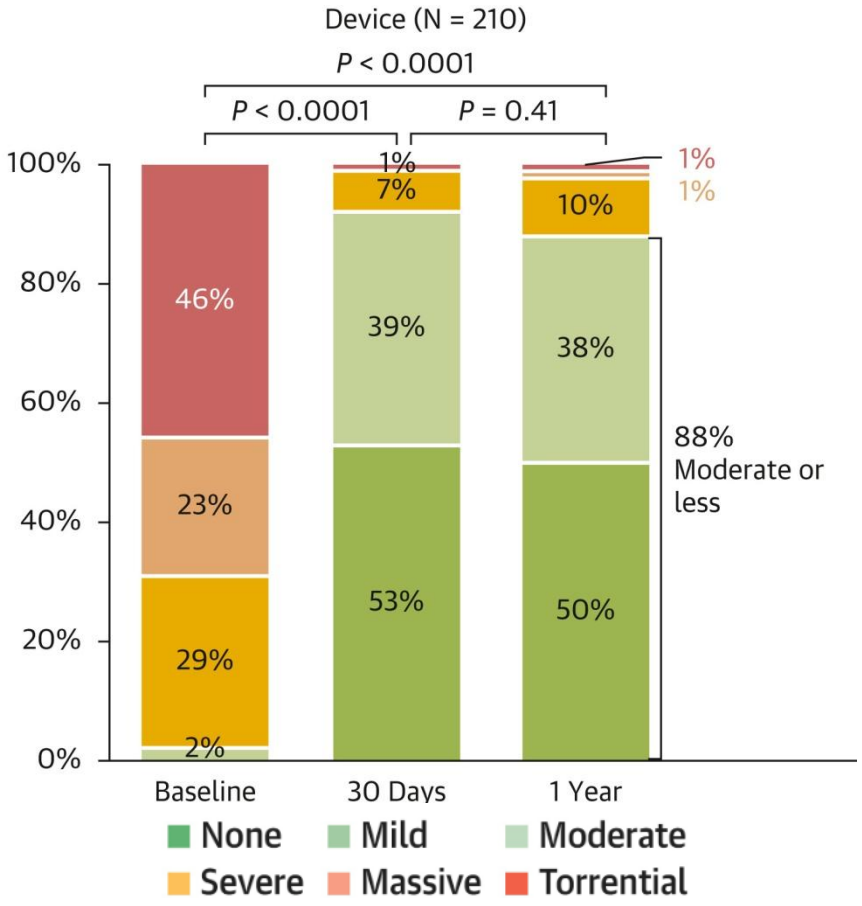
TRILUMINATE Pivotal Trial – katetrizační plastika (TEER) systémemTriClip

RCT, 350 symptomatických pacientů s TR ≥ 3+, ve vysokém riziku chirurgie, s PASP < 60mmHg, randomizace k T-TEER versus medikam. léčba

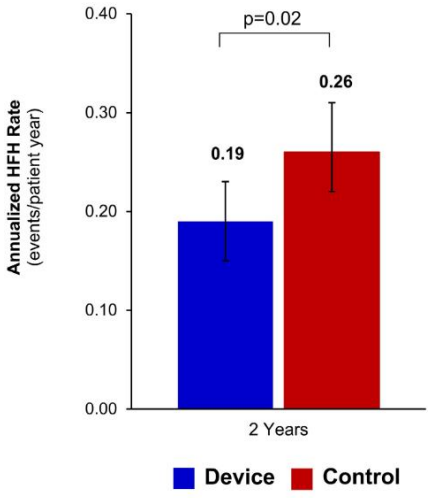


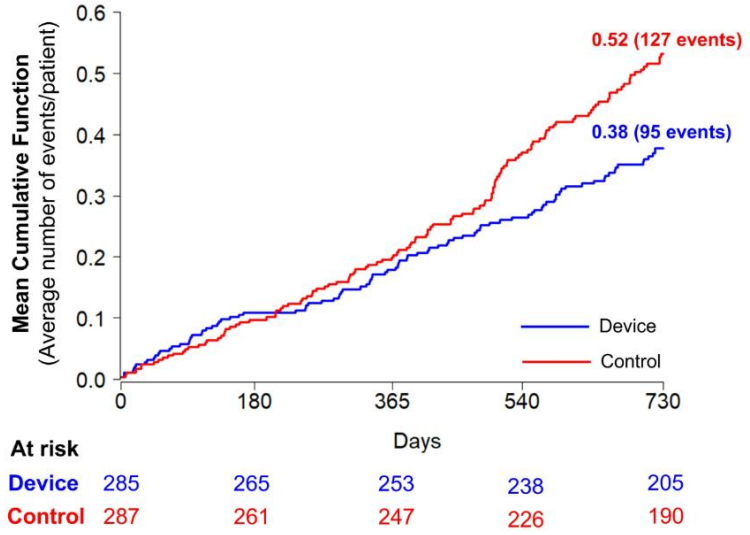


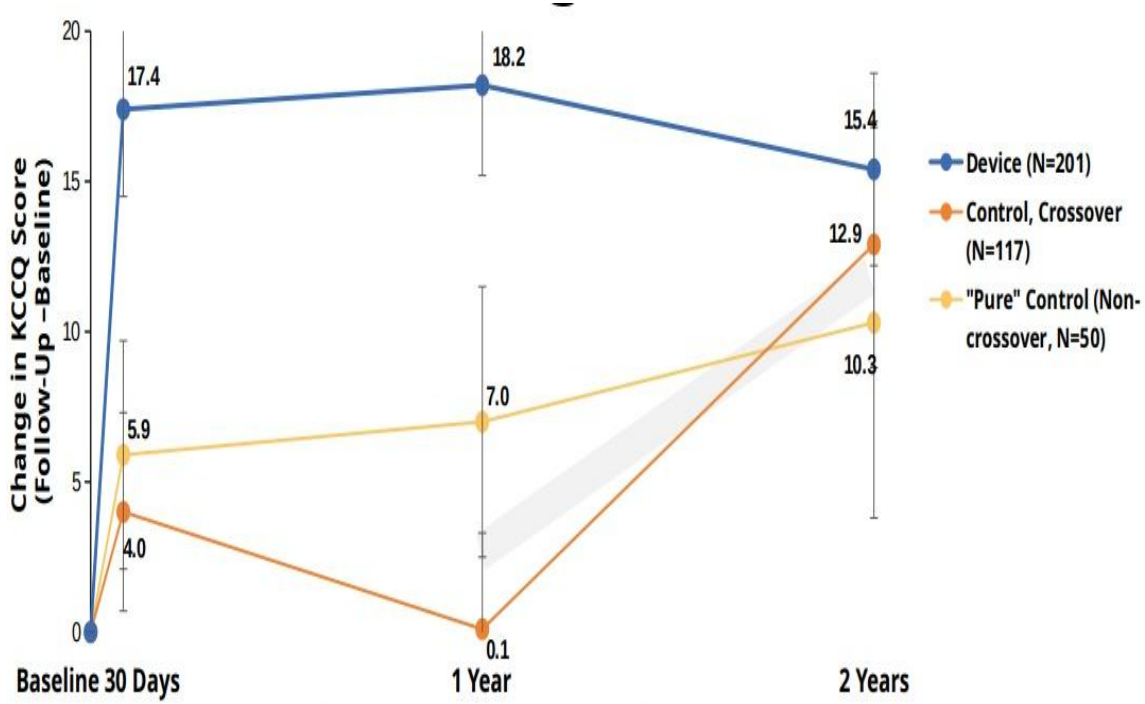
Sorajja P et al. NEJM 2023: 388:1833-42

TRILUMINATE – výsledky po 2 letech

Pokles hospitalizací pro srdeční selhání







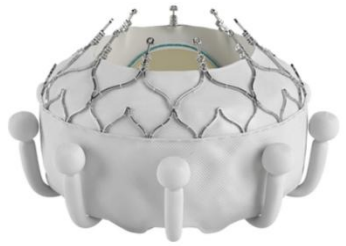
28% relative risk reduction in HFH with TriClip device treatment

HR 0.72 (two-sided 95%CI [0.53, 0.98])

Crossover k T-TEER u 60% pacientů

Kar S. et al. Circulation 2025; 151(23) , https://doi.org/10.1161/CIRCULATIONAHA.125.074536

TRISCEND II – katetrizační náhrada chlopně u TR


EVOQUE implant

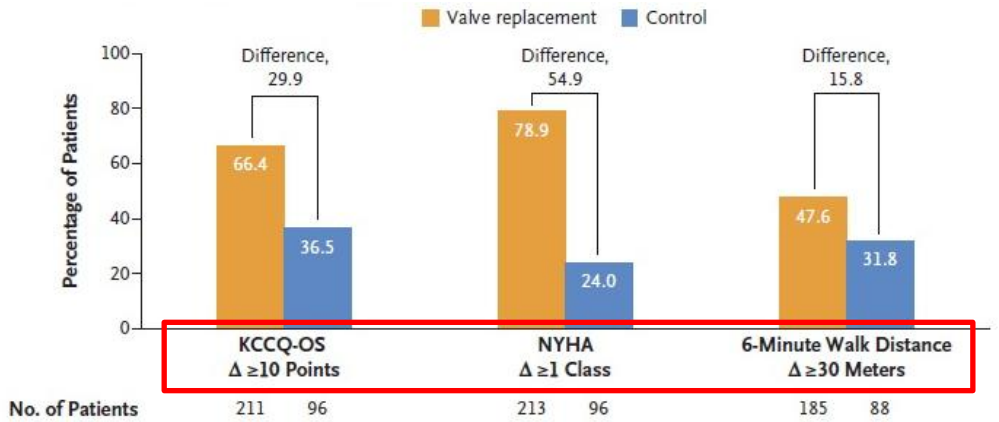
RCT, 400 pacientů se symptomatickou TR
randomizováno 2:1 k náhradě Evoque+OMT vs. OMT

Primární endpoint po 1 roce, kompozitní ⇩

	Valve Replacement (N=259) Valve replacement wins	34,447 Patient Pairs Ties % (no. of pairs)	Control (N=133) Control wins
Death from Any Cause (site reported and vital status sweep)	14.8 (5,100)	72.7 (25,050)	12.5 (4,297)
Right Ventricular Assist Device or Heart Transplant (clinical events committee adjudicated)	0	72.7 (25,050)	0
Tricuspid-Valve Intervention (clinical events committee adjudicated)	3.2 (1,105)	68.9 (23,731)	0.6 (214)
Annualized Rate of Hospitalization for Heart Failure (clinical events committee adjudicated)	9.7 (3,340)	49.2 (16,952)	10.0 (3,439)
KCCQ-OS Improvement (Δ score ≥10 points)	23.1 (7,959)	20.1 (6,927)	6.0 (2,066)
NYHA Improvement (Δ ≥1 class)	10.2 (3,502)	9.1 (3,148)	0.8 (277)
6-Minute Walk Distance Improvement (Δ ≥30 m)	1.1 (391)	7.1 (2,459)	0.9 (298)
	62.1 (21,397)		**30.7 (10,591)**

Win ratio=2.02 (95% CI, 1.56–2.62)
Finkelstein–Schoenfeld: P<0.001

Zlepšení kvality života, NYHA a 6MWT po 1 roce



- Náhrada chlopně ale spojena s více krváceními a **implantací kardiostimulátoru** (17% vs 2%)

Hahn RT al. NEJM 2025

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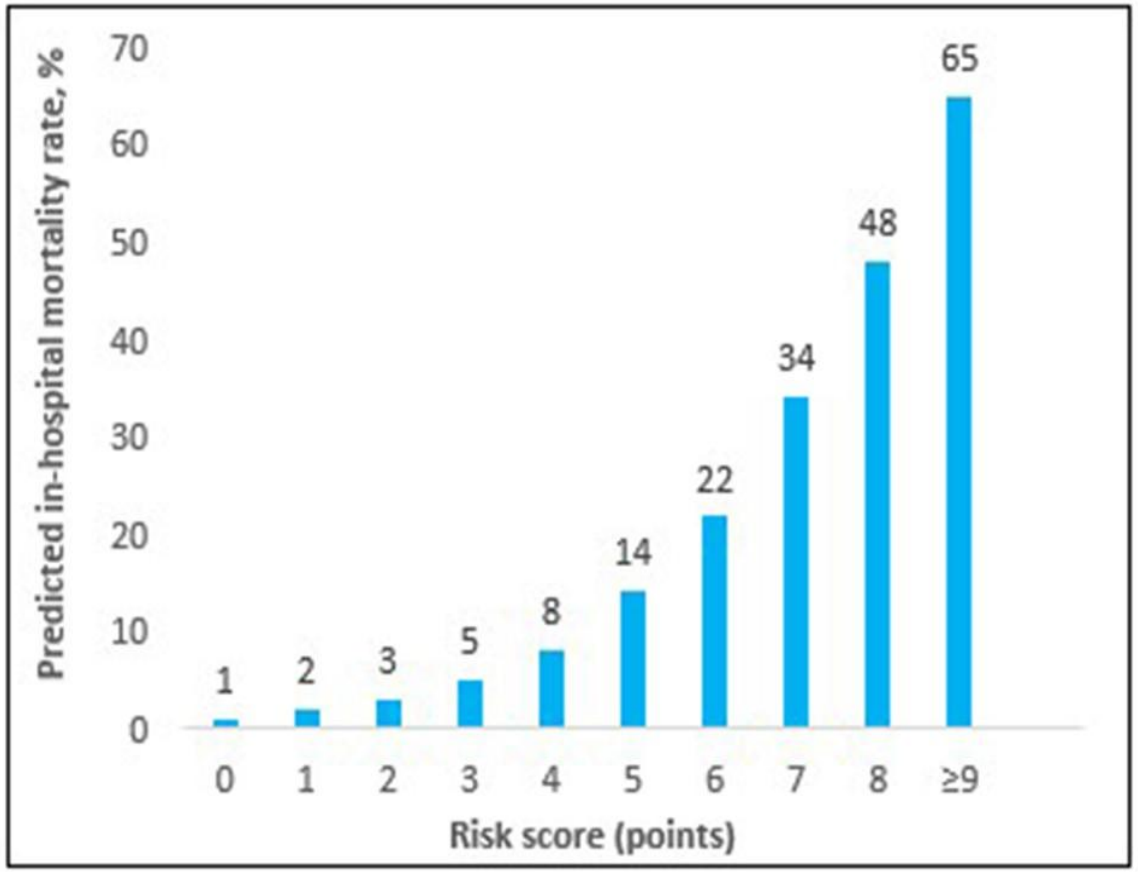
Tri-Score – odhad časné mortality operace izolované TR

Risk factors (final model from multivariate analysis)	Scoring
Age ≥ 70 years	1
NYHA functional class III-IV	1
Right-sided heart failure signs	2
Daily dose of furosemide ≥ 125mg	2
Glomerular filtration rate < 30 ml/min	2
Elevated total bilirubin	2
Left ventricular ejection fraction < 60%	1
Moderate/severe right ventricular dysfunction	1
Total	12

Časná operační mortalita podle Tri-Score



Dreyfus G. EHJ 2022, 43 *(7):* 654–662

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Tri-Score – odhad časné mortality operace izolované TR

TRI-SCORE CALCULATOR

Parameters

- [x] Age ≥ 70 years
- [ ] Female
- [x] NYHA functional class III or IV
- [x] Right-sided heart failure signs [1]
- [ ] Prior left-sided heart valve intervention
- [ ] Permanent pacemaker / defibrillator
- [x] Atrial fibrillation / flutter
- [ ] Daily dose of furosemide ≥ 125 mg
- [ ] Glomerular filtration rate < 30 ml/min [2]
- [ ] Elevated total bilirubin [3]
- [ ] Left ventricular ejection fraction < 60% [4]
- [x] Moderate/severe right ventricular dysfunction [5]

Mechanism of tricuspid regurgitation

- [x] Secondary
- [ ] Primary
- [ ] Mixed

Prediction

TRI-SCORE

5/12

Predicted in-hospital mortality after isolated tricuspid valve surgery

14%

Risk

https://www.tri-score.com/

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TRIGISTRY – 2-leté přežívání podle typu intervence

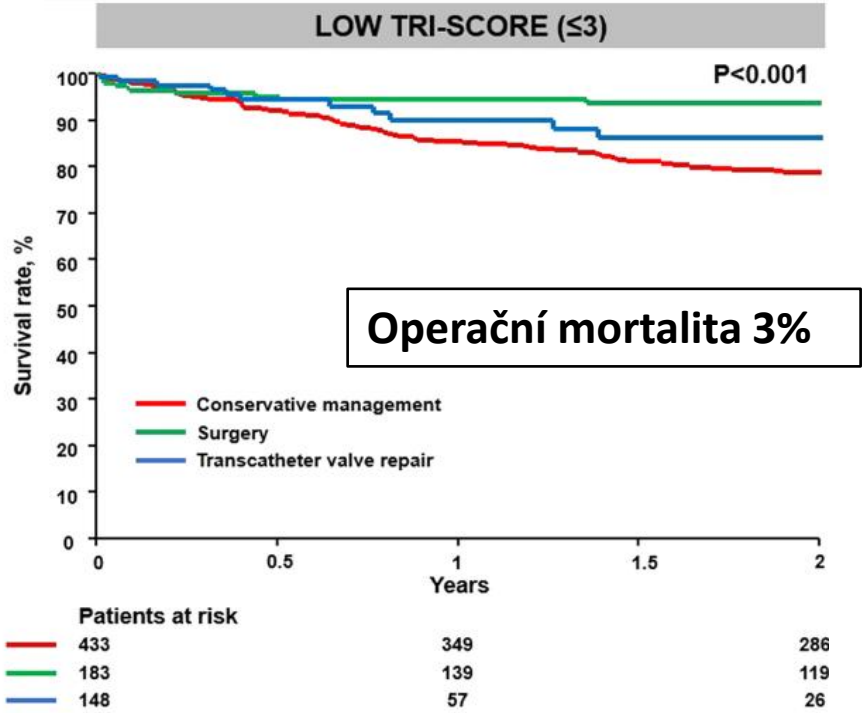
TRIGISTRY: multicenter registry (33 centers, 10 countries)

2413 patients with severe isolated functional tricuspid regurgitation

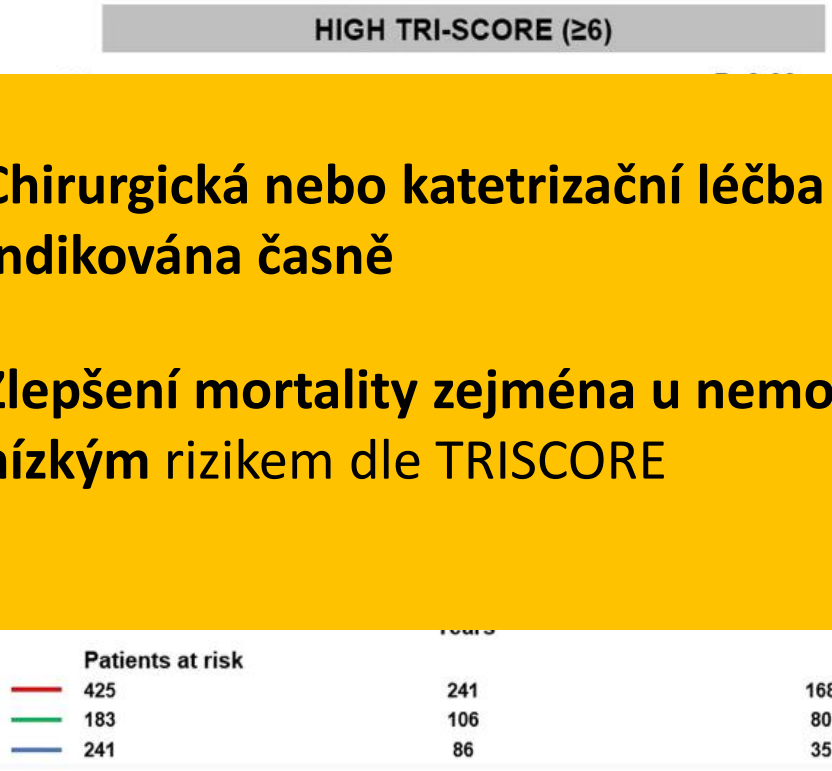
Comparison of survival rates at 2 years between different treatment modalities according to TRI-SCORE categories (low, intermediate and high)

- 1217 patients conservatively managed
- 551 underwent isolated tricuspid valve surgery
- 645 underwent transcatheter valve repair

Low TRI-SCORE (≤ 3) | Intermediate TRI-SCORE (4–5) | High TRI-SCORE (≥ 6)



Operační mortalita 3%



Chirurgická nebo katetrizační léčba má být indikována časně

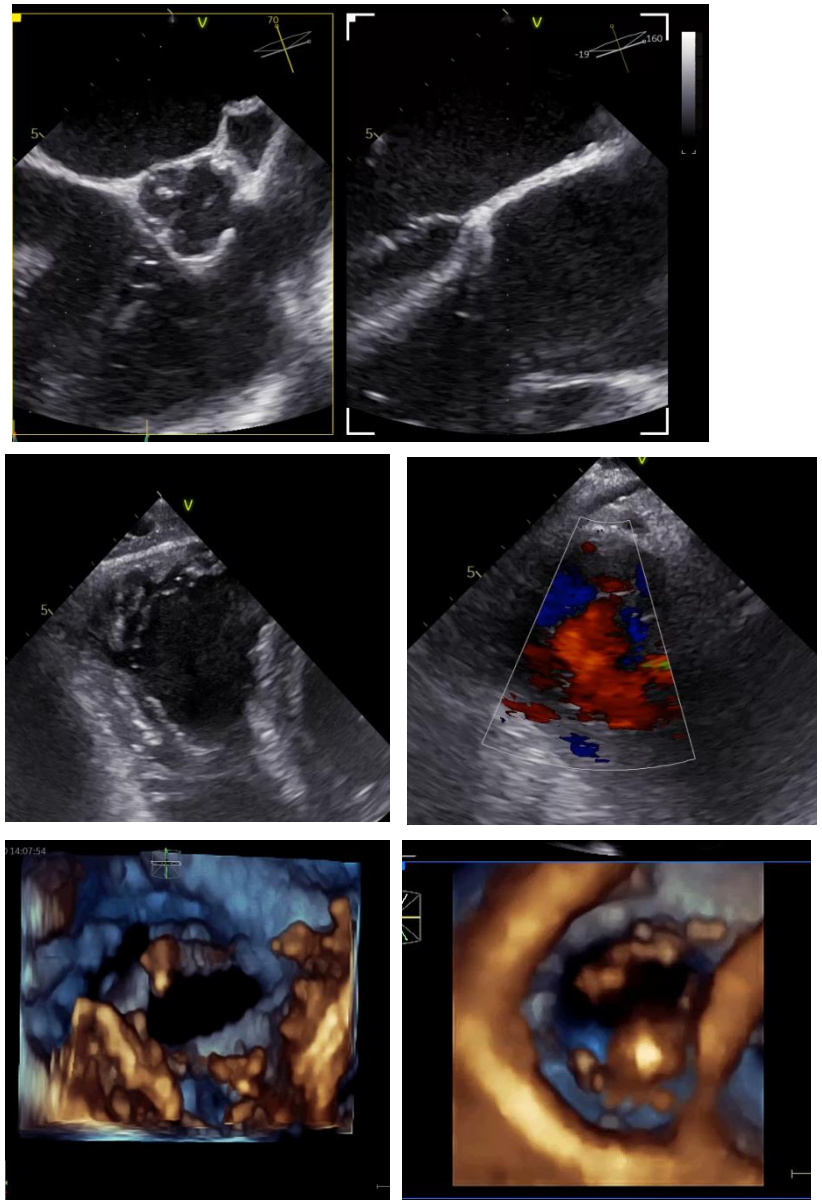
Zlepšení mortality zejména u nemocných s nízkým rizikem dle TRISCORE

Dreyfus J. Eur Heart J, Volume 45, Issue 8, 21 February 2024, Pages 586–59

Anatomická vhodnost k intervenci

Table 3. Anatomical criteria for device selection.

Strategy	Favourable anatomy	Feasible anatomy	Unfavourable anatomy
T-TEER 	Small septolateral gap ≤7 mm[10] Anteroseptal jet location Confined prolapse or flail Trileaflet morphology	Septolateral coaptation gap >7 but ≤8.5 mm[65] Posteroseptal jet location Non-trileaflet morphology Incidental CIED RV lead (i.e., without leaflet impingement)	Large septolateral coaptation gap >8.5 mm[65] Leaflet thickening/shortening (rheumatic, carcinoid)/perforation Dense chordae with marked leaflet tethering Anteroposterior jet location Poor echocardiographic leaflet visualisation CIED RV lead leaflet impingement Unfavourable device angle of approach
Annuloplasty 	Annular dilatation as primary mechanism of TR Mild tethering (tenting height <0.76 cm, tenting area<1.63 cm², tenting volume [3D] <2.3 mL)[110,111] Central jet location Sufficient landing zone for anchoring	Moderate tethering (tethering height ≥0.76 cm but <1.0 cm, tenting area >1.63 but <2.5 cm², tenting volume [3D] ≥2.3 mL but ≤3.5 mL)[110,111] Incidental CIED RV lead (i.e., without leaflet impingement)	Excessive annular dilatation (exceeding device size) Severe tethering (tethering height >1.0 cm, tenting volume >3.5 mL). Poor echocardiographic annular visualisation[110,111] Annular proximity of RCA CIED RV lead leaflet impingement
Orthotopic valve implantation 	Previous surgical repair or bioprosthetic valve replacement Leaflet thickening/shortening (rheumatic, carcinoid) Incidental CIED RV lead (i.e., without leaflet impingement) Any leaflet morphology	Large coaptation gap CIED RV lead leaflet impingement	Excessive annular dilatation (exceeding device size) Unfavourable device angle of approach Severe right ventricular dysfunction



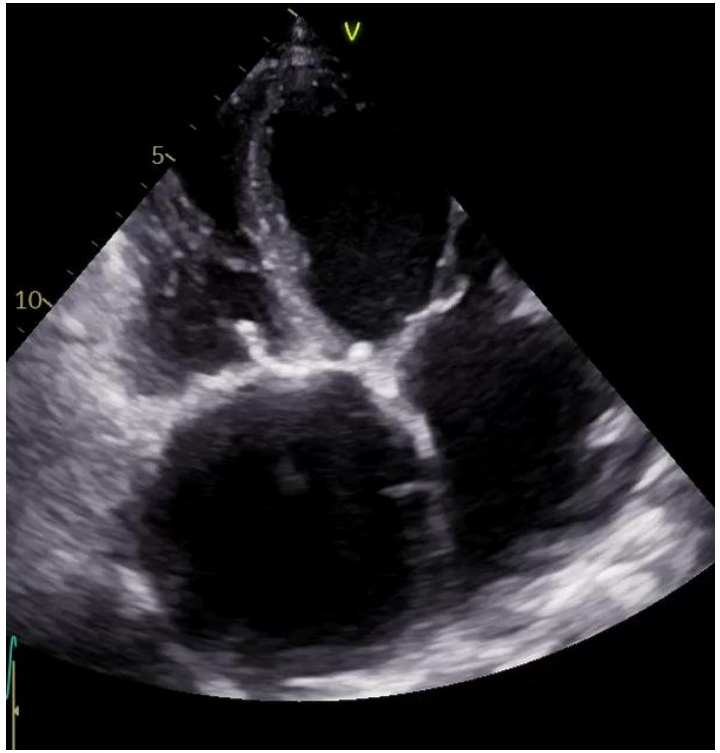
Praz F. Eurointervention 2021; 17: 791-808

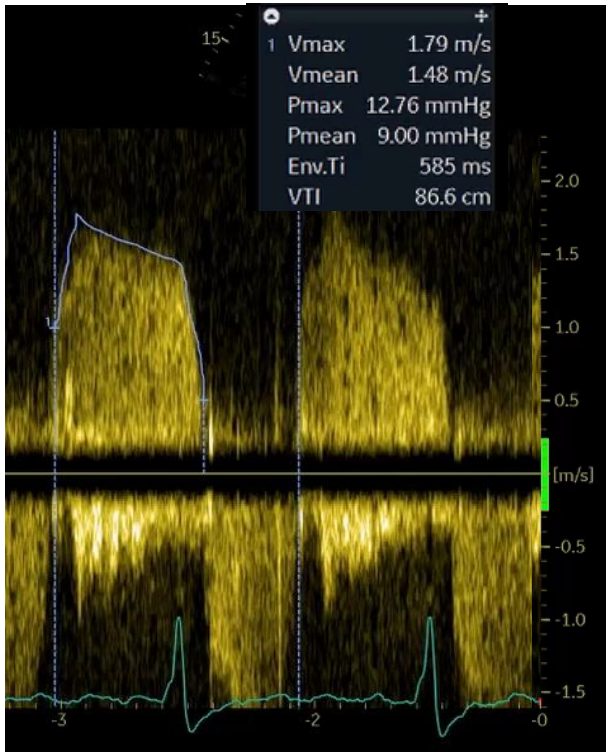
Trikuspidální stenóza

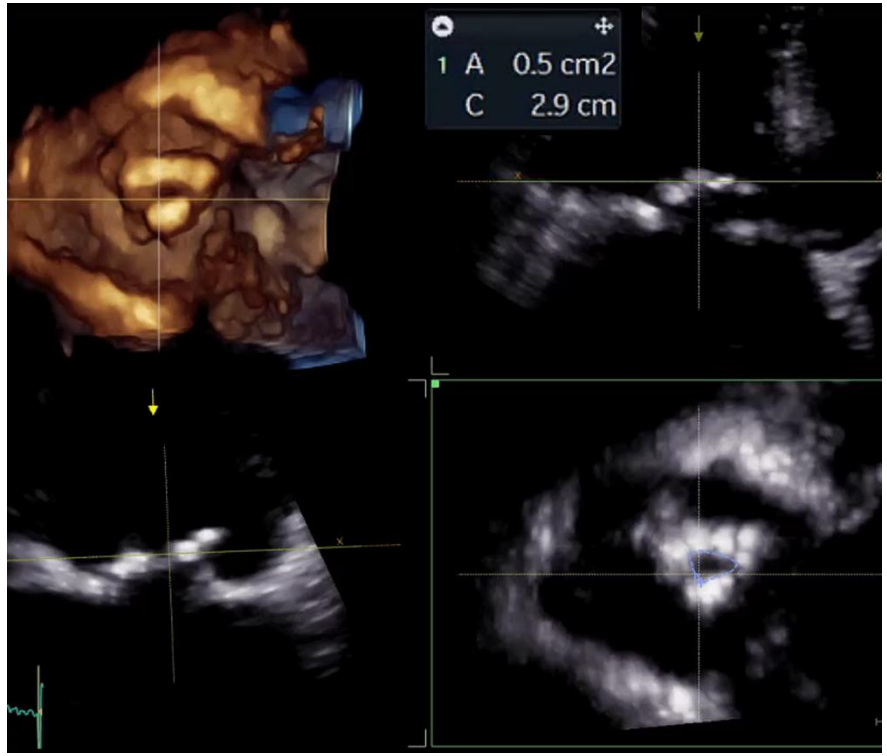
Etiologie - porevmatická, degenerace bioprotézy**,** vrozená, IE, tumor síně, karcinoid

Echokg kvantifikace vady - významná stenóza

PGmean ≥ 5mmHg, PHT ≥ 190ms 3D planimetrie < 1cm^2







Zdroj: Všeobecná fakultní nemocnice v Praze

Trikuspidální stenóza

Recommendations on tricuspid stenosis		
Operace je doporučena u symptomatické významné trikuspidální stenózy	I	C
Operace je doporučena u pacientů s významnou trikuspidální stenózou podstupující operaci levostranné chlopně	I	C

→ **Náhrada bioprotézou,** ev. plastika chlopně s implantací prstence

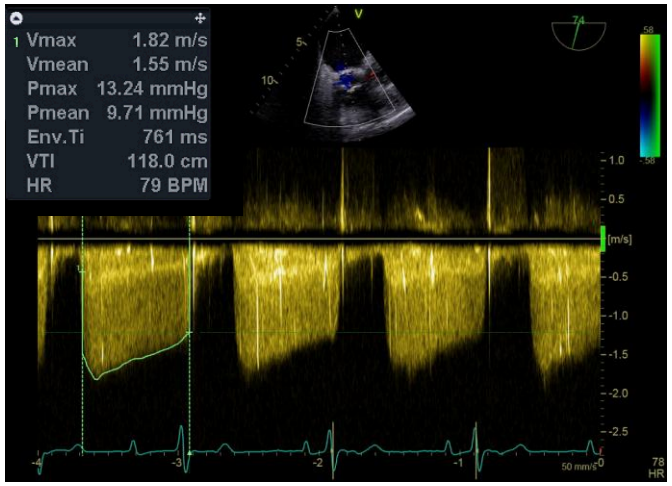
→ Perkutánní balónková valvuloplastika

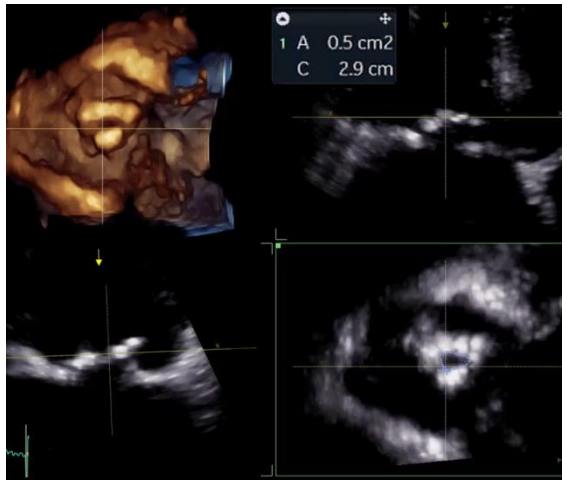
→ Katetrizační ViV implantace – degenerovaná bioprotéza

2021 ESC/EACTS guidelines, EHJ 2021;00: 1-72

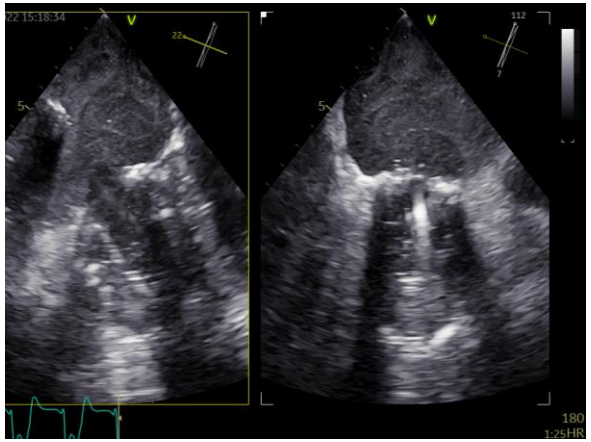
Náhrada trikuspidální chlopně valve-in-valve

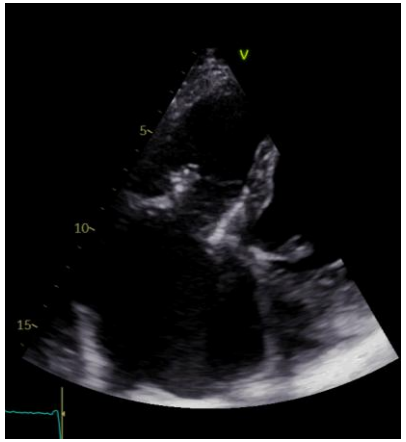
Významná stenóza trikuspidální bioprotézy

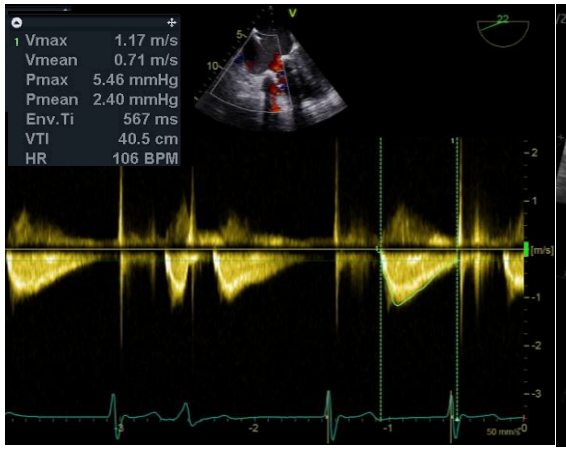


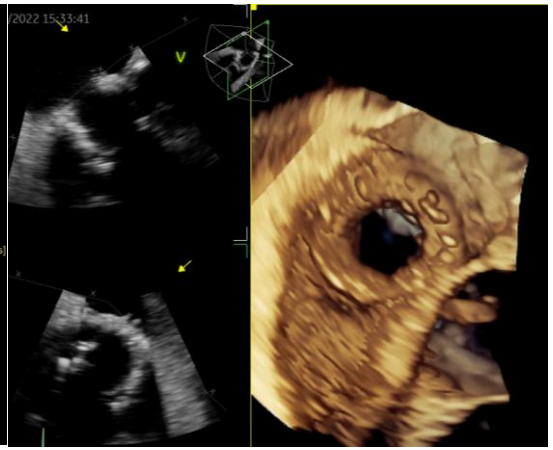


Implantace Sapien 3 valve-in-valve









Zdroj – Všeobecná fakultní nemocnice

Agricola E. et al, JACC CVI 2021; 14: 61-111

Závěr

- **Echokg** je základní metodou v hodnocení TR, funkce pravé komory, a anatomické vhodnosti k intervenci
- Nové změny v doporučeních

➢ **Trikuspidální anuloplastika** je indikována **při operaci levostranné vady u střední regurgitace** (IIa), u lehké regurgitace s dilatací anulu jen u vybraných pacientů (IIb)

➢ **Katetrizační intervence** symptomatické významné TR je indikována u nemocných **s vysokým rizikem operace** (IIa)

Děkuji za pozornost.

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