Hospices Civils de Lyon

Chirurgie Cardiovasculaire de l'Adulte

INSUFFISANCE TRICUSPIDE et LVAD

INSUFFISANCE TRICUSPIDE et TRANSPLANTATION CARDIAQUE

PLACE DE LA CHIRURGIE

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RESHAPE
Research on Healthcare Professionals and Performance

LIENS D’INTERET

Aucun conflit d’intérêt en rapport avec cette présentation

ANATOMIE FONCTIONNELLE
de la VALVE TRICUSPIDE

ANATOMIE FONCTIONNELLE de la VALVE TRICUSPIDE

UNITÉ ANATOMO-FONCTIONNELLE

Oreillette Droite

Anneau Feuillets Commissures

Piliers - Cordages

Ventricule Droit
Circulation Pulmonaire

JACC Cardiovasc Imaging 2019;12:458-468

Anneau Tricuspide

Terme inapproprié

- Jonction AV droite
- Anneau fibreux

- Pivot du mouvement
- Non visible

JACC Cardiovasc Imaging 2019;12:458-468

Carpentier's Reconstructive Valve Surgery – Saunders 2010

Anneau Tricuspide

Forme 3D

« Saddle-shape » / « Wave-form »

- Septale (Trigone)
- Antérieure et Postérieure (Musculaire)

Carpentier's Reconstructive Valve Surgery – Saunders 2010

Anneau Tricuspide

Structure dynamique

- Forme asymétrique
  - Circulaire pendant la diastole
  - Ovalaire pendant la systole
- Δ Systole-Diastole = 10-30%

Carpentier's Reconstructive Valve Surgery – Saunders 2010

ANATOMIE FONCTIONNELLE de la VALVE TRICUSPIDE

RAPPORTS ANATOMIQUES

V. aortique

Nœud AV

JACC Cardiovasc Imaging 2019;12:458-468

Carpentier's Reconstructive Valve Surgery – Saunders 2010

Feuillets valvulaires

Feuillet Antérieur > **Feuillet Postérieur** > **Feuillet Septal**

Forme demi-circulaire — **Forme trapézoïdale** — **Forme demi-circulaire**

Carpentier's Reconstructive Valve Surgery – Saunders 2010

Feuillets valvulaires

Coté atriale
2 zones

Ligne de coaptation

Zone proximale fine
(zone « atriale »)

Zone distale rugueuse
(zone « de coaptation »)

Insertion des cordages sur son coté ventriculaire

Appareil Sous-Valvulaire

Piliers (*propriétés contractiles*)

Trois Groupes

ANTERIEUR **POSTERIEUR** **SEPTAL**

JACC Cardiovasc Imaging 2019;12:458-468

Carpentier's Reconstructive Valve Surgery – Saunders 2010

Appareil Sous-Valvulaire

Cordages Tendineux *(propriétés élastiques)*

Classification (I)
Site d'implantation

1. Feuillet antérieur
2. Feuillet postérieur
3. Feuillet septal
4. Commissures

Classification (II)
Hauteur d'implantation

1. Primaires (Marginaux)
2. Secondaires (Intermédiaires)
3. Tertiaires (Basaux)

Classification (III)
Position d'implantation

1. Paramédians
2. Principaux
3. Paracommissuraux
4. Commissuraux

Carpentier's Reconstructive Valve Surgery – Saunders 2010

VALVULOPATHIE TRICUSPIDE

Analyse fonctionnelle

« Triade physiopathologique »

ETIOLOGIE
cause de la pathologie

→ **I**
→ **II**

↓

LESIONS ANATOMIQUES
conséquence de la pathologie

↓

DYSFONCTION VALVULAIRE
conséquence des lésions

J Thorac Cardiovasc Surg 1983;86:323-337

Analyse fonctionnelle

TYPE I
mouvement valvulaire normal

TYPE II
mouvement valvulaire exagéré (prolapsus)

TYPE III
mouvement valvulaire réduit (restriction)

IIIa: diastolique

IIIb: systolique

J Thorac Cardiovasc Surg 1983;86:323-337

Insuffisance tricuspide

Primaire

EI (toxicomanie i.v.)

RAA

Syndrome carcinoïde

Cardiopathies congenitales

Formes dystrophiques

Traumatique → **Sonde PM - DAI / Biopsie endomyocardique chez le greffé**

Iatrogene

Insuffisance tricuspide

Secondaire

Dilatation VD

valvulopathie mitrale, CMD, CMI

Dilatation OD

ACFA permanente

Insuffisance tricuspide de grade sévère

Critères échocardiographiques

1) **Vena contracta > 7 mm**

2) **SOR > 40 mm^2**

3) **VR > 45 ml/battement**

EUROPEAN SOCIETY OF CARDIOLOGY®

ESC/EACTS GUIDELINES

Eur Heart J 2021;42:3599-3726

Insuffisance tricuspide primaire

1) IT sévère symptomatique — Classe I

2) IT sévère chez un patient avec une autre indication opératoire (v. mitrale, v. aortique, etc.) — Classe I

3) IT sévère avec dilatation du VD — Classe IIa

4) IT modérée chez un patient avec une autre indication opératoire (v. mitrale, v. aortique, etc.) — Classe IIa

EUROPEAN SOCIETY OF CARDIOLOGY®

ESC/EACTS GUIDELINES

Eur Heart J 2021;42:3599-3726

Insuffisance tricuspide secondaire

1) IT sévère chez un patient avec une autre indication opératoire (v. mitrale, v. aortique, etc.) Classe I

2) IT sévère avec dilatation du VD Classe IIa

3) IT avec dilatation annulaire (> 40 mm ou >21 mm/m^2) Classe IIa

EUROPEAN SOCIETY OF CARDIOLOGY®

ESC/EACTS GUIDELINES

Eur Heart J 2021;42:3599-3726

INSUFFISANCE TRICUSPIDE et LVAD

PATHOLOGIE VALVULAIRE et LVAD

1) Valve aortique → **RA**
IA → **préexistante**
de novo

2) Valve mitrale → **RM**
IM

3) Valve tricuspide → **IT**

4) Prothèse valvulaire → **RVA / RVM biologique**
RVA / RVM mécanique
MitraClip

Circ Heart Fail 2014;7:215-222
Can J Cardiol 2020;36:244-260

PATHOLOGIE VALVULAIRE et LVAD

Recommendations for aortic valve disease:
Class I:

1. Functioning bioprosthetic valves do not require removal or replacement at the time of implant.
   Level of evidence: C.

2. Replacement of a pre-existing aortic mechanical valve with a bioprosthetic valve or oversewing the aortic valve at the time of implantation is recommended.
   Level of evidence: C.

Recommendations for aortic regurgitation:
Class I:

1. More than mild aortic insufficiency should prompt consideration for surgical intervention during device implantation.
   Level of evidence: C

Recommendations for aortic stenosis:
Class I:

1. Patients with aortic stenosis of any degree that is accompanied by more than mild aortic insufficiency should prompt consideration for a bioprosthetic aortic valve replacement during MCS implant (see Section 3).
   Level of evidence: C.

Class IIb:

1. Patients with severe aortic stenosis may be considered for aortic valve replacement, regardless of the degree of concomitant aortic insufficiency.
   Level of evidence: C.

Recommendations for mitral valve:
Class IIb:

1. Severe mitral insufficiency is not a contraindication to MCS and does not routinely require surgical repair or valve replacement, unless there is expectation of ventricular recovery.
   Level of evidence: C.

Class III:

1. Routine mitral valve repair or replacement for severe mitral regurgitation is not recommended.
   Level of evidence: C.

Recommendations for mitral valve stenosis:
Class I:

1. Valve replacement with a tissue valve should be considered if there is moderate or worse mitral valve stenosis at the time of left ventricular assist device (LVAD) implantation.
   Level of evidence: C

Recommendations for mechanical mitral valves:
Class III:

1. Routine replacement of properly functioning mechanical mitral valve is not recommended.
   Level of evidence: C.

Recommendations for tricuspid valve regurgitation:
Class IIa:

1. Moderate or greater tricuspid regurgitation should prompt consideration of surgical repair at the time of implant.
   Level of evidence: C.

J Heart Lung Transplant 2013;32:157–187

PATHOLOGIE VALVULAIRE et LVAD

Aortic valve and root diseases		
Biological valve replacement in patients with more than mild aortic insufficiency should be considered.	IIa	B
Application of a central leaflet coaptation stitch may be considered in patients with more than mild aortic insufficiency.	IIb	B
Closure of aortic valve in patients with more than mild aortic insufficiency is not recommended.	III	C
It is recommended that a functional bioprosthesis be left in place.	I	C
Replacement of a mechanical aortic valve with a biological valve is recommended.	I	C
Closure of mechanical aortic valves is not recommended.	III	C
Surgical correction of an ascending aorta aneurysm at the time of implantation of a ventricular assist device should be considered.	IIa	C

Mitral valve disease		
Correction of moderate or severe mitral stenosis of any cause (including transcatheter interventions) is recommended.	I	C
In selected patients, the repair of severe mitral insufficiency may be considered.	IIb	C
Exchange of a functional mitral mechanical or biological prosthesis at the time of long-term mechanical circulatory support device implantation is not recommended.	III	C
In patients previously treated with a MitraClip, a thorough evaluation to rule out the existence of mitral valve stenosis is recommended.	I	C

Tricuspid valve disease and right ventricular dysfunction		
Correction of severe tricuspid stenosis at the time of long-term mechanical circulatory support implantation is recommended.	I	C
Re-evaluation of patients with moderate to severe tricuspid regurgitation after treatment with diuretic therapy, if condition permits, is recommended.	I	C
In carefully selected patients, tricuspid valve repair for moderate to severe tricuspid regurgitation at the time of long-term mechanical circulatory support implantation may be considered.	IIb	C
Implantation of a biventricular assist device or a total artificial heart in patients with severe tricuspid regurgitation and right ventricular dysfunction may be considered.	IIb	C

Eur J Cardiothorac Surg 2019;56:230-270

Quel est l'impact sur les résultats des LVAD d'une IT modérée à sévère non corrigée lors de l'intervention chirurgicale?

INSUFFISANCE TRICUSPIDE et LVAD

Clinical impact and 'natural' course of uncorrected tricuspid regurgitation after implantation of a left ventricular assist device: an analysis of the European Registry for Patients with Mechanical Circulatory Support (EUROMACS)

2005 - 2018

2496 LVAD

Pas de chirurgie tricuspide associée

Sévérité de l'IT (de 0 à 4)

- Groupe IT absente à minime (67.7%)

IDM récent, INTERMACS 1
sous ECMO VA, intubé

- Groupe IT modérée à sévère (32.3%)

IC chronique, INTERMACS 4
IVD modérée à sévère

euromacs
European Registry for Patients with Mechanical Circulatory Support e.V.

Eur J Cardiothorac Surg 2021;59:207-216

INSUFFISANCE TRICUSPIDE et LVAD

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Eur J Cardiothorac Surg 2021;59:207-216

TAKE HOME MESSAGE

1

IT modérée à sévère pré-LVAD
40-50%

J Thorac Cardiovasc Surg 2012;144:1217-1221
Am J Cardiol 2018;122:115-120

IT modérée à sévère post-LVAD
23-40%

J Heart Lung Transplant 2008;27:1275-1281
Ann Thorac Surg 2016;101:2168-2174

Impact négatif sur la
survie postopératoire et à long terme

Eur J Cardiothorac Surg 2021;59:207-216
J Am Heart Assoc 2018;7:e008813

Quel est l'intérêt d'un geste chirurgical sur la valve tricuspide lors de la pose du LVAD?

CHIRURGIE TRICUSPIDE et LVAD

Clinical impact of concomitant tricuspid valve procedures during left ventricular assist device implantation

2008 - 2017

15447 LVAD

Intermacs

J Heart Lung Transplant 2020;39:926-933

CHIRURGIE TRICUSPIDE et LVAD

Clinical impact of concomitant tricuspid valve procedures during left ventricular assist device implantation

Groupe avec chirurgie tricuspide associée (16.5%)

IC chronique, INTERMACS 4, DT / BTC

IVD modérée à sévère, HTAP → *RVAD*

Groupe sans chirurgie tricuspide associée (83.5%)

INTERMACS 1

sous ECMO VA, intubé

→ **Chirurgie réparatrice 95.1%**

Intermacs

J Heart Lung Transplant 2020;39:926-933

CHIRURGIE TRICUSPIDE et LVAD

Clinical impact of concomitant tricuspid valve procedures during left ventricular assist device implantation

Intermacs

J Heart Lung Transplant 2020;39:926-933

CHIRURGIE TRICUSPIDE et LVAD

Outcomes after tricuspid valve surgery concomitant with left ventricular assist device implantation in the EUROMACS registry: a propensity score matched analysis

1995 - 2018

3323 LVAD

292 PLT (97.7%)

7 RVT (2.3%)

Sans chirurgie tricuspide associée 3024 (91%)

Avec chirurgie tricuspide associée 299 (9%)

Sans chirurgie tricuspide associée 258

PSM

Avec chirurgie tricuspide associée 258

euromacs
European Registry for Patients with Mechanical Circulatory Support e.V.

Eur J Cardiothorac Surg 2019;56:1081-1089

CHIRURGIE TRICUSPIDE et LVAD

Outcomes after tricuspid valve surgery concomitant with left ventricular assist device implantation in the EUROMACS registry: a propensity score matched analysis

	Matched groups		
	No TVS	TVS	*P*-value
n	258	258	
CPB time (min), median (IQR)	84.50 (61.00–114.50)	115.50 (92.25–157.75)	<0.001
Device brand, *n* (%)			0.93
HeartMate II	102 (39.5)	96 (37.2)	
HeartWare HVAD	112 (43.4)	113 (43.8)	
HeartMate III	42 (16.3)	47 (18.2)	
Other	2 (0.8)	2 (0.8)	
Hospital deaths, *n* (%)	50 (20.2)	45 (16.5)	0.41
30-Day deaths, *n* (%)	32 (13.6)	25 (10.0)	0.27
Temporary RVAD support, *n* (%)	22	16	0.40
Days of inotropic support, *n* (%)			0.29
1–7	11 (7.0)	13 (7.7)	
8–13	85 (53.8)	85 (50.6)	
14–27	27 (17.1)	41 (24.4)	
>27	33 (20.9)	29 (17.3)	
Ongoing	2 (1.3)	0 (0.0)	
ICU/CCU stay, median (IQR)	11.00 (5.00–24.00)	15.00 (6.00–31.00)	0.026
Hospital stay, median (IQR)	33.00 (22.00–54.00)	34.50 (24.75–52.25)	0.38

euromacs
European Registry for Patients with Mechanical Circulatory Support e.V.

Eur J Cardiothorac Surg 2019;56:1081-1089

CHIRURGIE TRICUSPIDE et LVAD

Outcomes after tricuspid valve surgery concomitant with left ventricular assist device implantation in the EUROMACS registry: a propensity score matched analysis

euromacs
European Registry for Patients with Mechanical Circulatory Support e.V.

Eur J Cardiothorac Surg 2019;56:1081-1089

CHIRURGIE TRICUSPIDE et LVAD

Left ventricular assist device implantation with and without concomitant tricuspid valve surgery: a systematic review and meta-analysis

Janvier 2005 - Mars 2017

PLT 93.2%

RVT 6.8%

303 patients
LVAD + Chirurgie tricuspide

562 patients
LVAD

Eur J Cardiothorac Surg 2018;54:644-651

CHIRURGIE TRICUSPIDE et LVAD

Left ventricular assist device implantation with and without concomitant tricuspid valve surgery: a systematic review and meta-analysis

Characteristics	LVAD (*n* = 562)	95% CI	LVAD + TVS (*n* = 303)	95% CI	RR/MD	95% CI	*P*-value
Age (years)	56.0	54.8–57.2	56.9	55.1–58.7	-0.47	-2.8 to 1.9	0.693
Female (%)	24.0	20.4–28.8	40.8	34.1–48.7	0.71	0.52 to 0.94	0.020
Ischaemic heart disease (%)	44.0	39.6–48.8	41.0	34.8–48.2	1.15	0.93 to 1.4	0.195
Diabetes (%)	37.5	33.0–42.6	34.7	27.2–44.3	1.01	0.75 to 1.35	0.952
IABP (%)	41.6	36.6–47.2	47.6	41.1–55.1	0.92	0.76 to 1.20	0.407
Other valve procedure (%)	46.3	89.9–96.3	45.0	37.3–54.3	1.01	0.80 to 1.28	0.912
Moderate–severe TR (%)	93.1	89.9–96.3	97.5	95.2–99.9	0.93	0.89 to 0.97	<0.001
Severe TR (%)	17.7	11.8–26.4	57.4	49.9–66.6	0.47	0.28 to 0.80	0.006
CVP (mmHg)	10.8	10.3–11.3	12.9	12.0–13.8	-2.04	-3.08 to -0.99	<0.001
PCWP (mmHg)	23.3	22.5–24.1	23.4	22.4–24.4	-0.37	-1.69 to -0.95	0.672
Creatinine (mg/dl)	1.4	1.3–1.4	1.4	1.3–1.5	-0.07	-0.17 to 0.04	0.236
Bilirubin (mg/dl)	1.4	1.3–1.5	1.7	1.6–1.9	-0.21	-0.416 to -0.012	0.038
Continuous flow device (%)	99.7	99.2–100	98.8	97.3–100	1.00	0.998 to 1.02	0.602

Eur J Cardiothorac Surg 2018;54:644-651

CHIRURGIE TRICUSPIDE et LVAD

Left ventricular assist device implantation with and without concomitant tricuspid valve surgery: a systematic review and meta-analysis

A

Early mortality

Model	Study name	Risk ratio	Lower limit	Upper limit	Z-Value	p-Value	LVAD	LVAD + TVS
	Brewer RJ	1,770	0,247	12,665	0,569	0,570	11 / 87	1 / 14
	Han J	0,603	0,187	1,948	-0,845	0,398	8 / 252	4 / 76
	Krishan K	0,755	0,178	3,207	-0,381	0,703	2 / 14	7 / 37
	Oezpeker C	0,615	0,059	6,414	-0,406	0,685	1 / 26	2 / 32
	Piacentino V	1,179	0,077	17,993	0,118	0,906	1 / 28	1 / 33
	Saeed D	0,706	0,084	5,929	-0,321	0,748	3 / 34	1 / 8
	Maltais S	0,231	0,050	1,078	-1,864	0,062	2 / 49	6 / 34
Random		0,631	0,332	1,200	-1,405	0,160		

Statistics for each study — Risk ratio and 95% CI

I-squared: 0.00%, Q-value: 2.966, df(Q):6, P-value: 0.831

C

AKI

Model	Study name	Risk ratio	Lower limit	Upper limit	Z-Value	p-Value	LVAD	LVAD + TVS
	Han J	0,797	0,456	1,394	-0,795	0,426	37 / 252	14 / 76
	Oezpeker C	0,718	0,331	1,559	-0,838	0,402	7 / 26	12 / 32
	Piacentino V	1,684	0,738	3,839	1,239	0,215	10 / 28	7 / 33
	Saeed D	0,353	0,070	1,774	-1,264	0,206	3 / 34	2 / 8
	Maltais S	1,110	0,397	3,104	0,199	0,842	8 / 49	5 / 34
Random		0,901	0,621	1,309	-0,547	0,584		

Statistics for each study — Events / Total — Risk ratio and 95% CI

I-squared: 4.24%, Q-value: 4.177, df(Q):4, P-value: 0.383

Eur J Cardiothorac Surg 2018;54:644-651

CHIRURGIE TRICUSPIDE et LVAD

Left ventricular assist device implantation with and without concomitant tricuspid valve surgery: a systematic review and meta-analysis

B

RVF

Model	Study name	Risk ratio	Lower limit	Upper limit	Z-Value	p-Value	LVAD	LVAD + TVS
	Brewer RJ	0,483	0,181	1,287	-1,455	0,146	12 / 87	4 / 14
	Oezpeker C	0,856	0,589	1,244	-0,815	0,415	16 / 26	23 / 32
	Piacentino V	2,554	1,118	5,832	2,225	0,026	13 / 28	6 / 33
	Saeed D	0,235	0,058	0,957	-2,022	0,043	3 / 34	3 / 8
	Maltais S	0,752	0,392	1,442	-0,859	0,390	13 / 49	12 / 34
Random		0,811	0,459	1,432	-0,722	0,470		

Statistics for each study

Risk ratio and 95% CI

I-squared: 65.10%, Q-value: 11.445, df(Q):4, P-value: 0.022

RVAD implantation

Model	Study name	Risk ratio	Lower limit	Upper limit	Z-Value	p-Value	LVAD	LVAD + TVS
	Han J	0,829	0,272	2,530	-0,329	0,742	11 / 252	4 / 76
	Saeed D	0,706	0,084	5,929	-0,321	0,748	3 / 34	1 / 8
	Maltais S	0,694	0,103	4,688	-0,375	0,708	2 / 49	2 / 34
	Oezpeker C	1,231	0,607	2,497	0,575	0,565	10 / 26	10 / 32
Random		1,027	0,592	1,781	0,094	0,925		

Statistics for each study

Events / Total

Risk ratio and 95% CI

I-squared: 0.00%, Q-value: 0.674, df(Q):3, P-value: 0.879

Eur J Cardiothorac Surg 2018;54:644-651

CHIRURGIE TRICUSPIDE et LVAD

Left ventricular assist device implantation with and without concomitant tricuspid valve surgery: a systematic review and meta-analysis

Survie à moyen terme

Eur J Cardiothorac Surg 2018;54:644-651

CHIRURGIE TRICUSPIDE et LVAD

EXPERIENCE LYONNAISE

01/01/2010 - 10/03/2022
ACM de longue durée n = 128

LVAD
n = 105 (82.0%)

BiVAD
n = 20 (15.6%)

TAH
n = 3 (2.4%)

Avec chirurgie tricuspide associée
0 (0%)

RVA biologique (n=3)
Fermeture FOP (n=3)
Fermeture auricule gauche (n=3)
Traitement ACFA (n=1)
Intervention de Dor (n=1)
Fermeture Rashkind (n=1)

FRANCEMACS

01/01/2015 - 16/12/2021

1055 LVAD → 15 (1.4%) Plastie tricuspide

TAKE HOME MESSAGE

2

Chirurgie tricuspide pas très souvent associée à la pose d'un LVAD

1-17%

Aucun bénéfice sur la survie postopératoire de la chirurgie tricuspide associée à la pose du LVAD <u>indépendamment de la sévérité de l'IT préopératoire</u>

Eur J Cardiothorac Surg 2018;54:644-651
Eur J Cardiothorac Surg 2019;56:1081-1089
J Heart Lung Transplant 2020;39:926-933

PERSPECTIVES

PERSPECTIVES

ETUDES CLINIQUES

Randomized Study of the Clinical Impact of Surgical Correction of Tricuspid Insufficiency in Implantable LVAD Patients

Inclusion Criteria:

1. Participant or their legal representative has signed an informed consent
2. Over 18 years of age
3. Participant with advanced heart failure symptoms (Class III or IV) and preoperative mild tricuspid regurgitation who are scheduled for an implantable LVAD

40 patients

Study Start Date ICMJE	August 2015
Estimated Primary Completion Date	December 2025

20 patients
LVAD + Plastie tricuspide

20 patients
LVAD

NCT02537769

PERSPECTIVES

ETUDES CLINIQUES

Randomized Study of the Clinical Impact of Surgical Correction of Tricuspid Insufficiency in Implantable LVAD Patients

Primary Outcome Measures :

1. Change in TR severity assessment from baseline [Time Frame: 13 months]

   Tricuspid Regurgitation (TR) severity as measured by vena contracta width and area will be assessed using echocardiography within 7 days prior to implantation (baseline) up to 13 months postoperative. TR severity is assessed on a range of mild to severe.

Secondary Outcome Measures :

1. Change in quality of life (QOL) from baseline [Time Frame: 13 months]

   Functional status as measured by the Duke Activity Status Index (DASI) survey will be assessed within 7 days prior to implantation (baseline) up to 13 months postoperative.

2. Change in RV function from baseline [Time Frame: 13 months]

   Right ventricular (RV) function as measured by tricuspid annular plane systolic excursion (TAPSE) values will be assessed using echocardiography prior to implantation (baseline) up to 13 months postoperative.

NCT02537769

PERSPECTIVES

ETUDES CLINIQUES

Treatment of Tricuspid Valve Regurgitation in Patients Undergoing Left Ventricular Assist Device Implantation Study

Inclusion Criteria - Potential subjects must meet all inclusion criteria to participate.

- Planned LVAD implantation (either destination or bridge indication)
- 18 years of age or older
- Patients wilith mild tricuspid regurgitation (TR) during surgical planning will be screened for meeting inclusion criteria for this study.
- TR on pre-operative echo (within one week of procedure) (TTE or intraoperative TEE) quantified as moderate or severe with normal tricuspid valve leaflets

Actual Study Start Date ICMJE	August 22, 2018
Estimated Primary Completion Date	December 31, 2022

270 patients

135 patients
LVAD + PLT /RVT

135 patients
LVAD

NCT03775759

PERSPECTIVES

ETUDES CLINIQUES

Treatment of Tricuspid Valve Regurgitation in Patients Undergoing Left Ventricular Assist Device Implantation Study

Primary Outcome Measures ℹ :

1 Proportion of patients experiencing moderate or greater right heart failure within 6 months post-operatively [Time Frame: 6 months post-operatively]

Patients experiencing moderate or greater right heart failure as defined by Interagency Registry for Mechanically Assisted Circulatory Support (INTERMACS) criteria

NCT03775759

PERSPECTIVES

TRAITEMENT PERCUTANÉ

TECHNIQUES

Prog Cardiovasc Dis 2021 [Online ahead of print]

PERSPECTIVES

TRAITEMENT PERCUTANÉ

Transcatheter edge-to-edge tricuspid repair for recurrence of valvular regurgitation after left ventricular assist device and tricuspid ring implantation

ESC Heart Fail 2020;7:915-919

INSUFFISANCE TRICUSPIDE et TRANSPLANTATION CARDIAQUE

SOMMAIRE

1) ETIOLOGIE

2) PRISE EN CHARGE CHIRURGICALE

3) PRISE EN CHARGE PERCUTANEE

4) PREVENTION

INSUFFISANCE TRICUSPIDE et TRANSPLANTATION CARDIAQUE

ETIOLOGIE

INSUFFISANCE TRICUSPIDE

PRIMAIRE (organique)

1) traumatique après BEM

SECONDAIRE (fonctionnelle)

1) Technique biatriale

2) IVD

J Heart Lung Transplant 2008;27:247-252
Ann Cardiothorac Surg 2017;6:270-274

INSUFFISANCE TRICUSPIDE et TRANSPLANTATION CARDIAQUE

ETIOLOGIE

IT traumatique après BEM

Transplant Int 1992;5(Suppl 1):S255-S258

INSUFFISANCE TRICUSPIDE et TRANSPLANTATION CARDIAQUE

ETIOLOGIE

IT traumatique après BEM

2003 - 2010

175 patients greffés

2217 BEM / 4972 fragments (2.3 f/BEM)

Présence du tissu de cordages
19 (10.8%) patients

↓

2 IT minime
0 IT sévère

Transplant Proc 2011;43:1908-1912

1985 - 2010

417 patients greffés

3550 BEM / 17550 fragments (4.9 f/BEM)

Présence du tissu de cordages
12 (2.8%) patients

↓

2 IT modérée
0 IT sévère

Transplant Proc 2012;44:2479-2482

ETIOLOGIE

IT traumatique après BEM

Tricuspid Regurgitation After Cardiac Transplantation: How Many Biopsies Are Too Many?

1987 - 2001

101 greffes

mild and moderate TR

severe TR

p< 0.0001

25 patients

IT sévère

J Heart Lung Transplant 2005;24:S227-S231

ETIOLOGIE

IT traumatique après BEM

Eur J Heart Fail 2021;23:854-871

INSUFFISANCE TRICUSPIDE et TRANSPLANTATION CARDIAQUE

ETIOLOGIE

IT traumatique après BEM

Proposed rsEMB schedule*	Time after HTx (weeks)		
	High diagnostic yield	Intermediate diagnostic yield	Low diagnostic yield
Low-frequency schedule (8 rsEMB per year)	2, 4, 8, 12, 16, 20, 24	36 and 48	-
Moderate-frequency schedule (9-13 rsEMB per year)	1, 2, 3, 4, 6, 8, 12, 16, 22	28, 36, 44	52
High-frequency schedule (≥14 rsEMB per year)	1, 2, 3, 4, 6, 8, 12, 16, 22	28, 36, 44	52, and then once a year for 5 years after HTx

Eur J Heart Fail 2021;23:854-871

ETIOLOGIE

IT traumatique après BEM

PROTOCOLE BEM LYON

- **1 BEM / semaine (à partir de la 2ème semaine et jusqu'à la sortie en SSR)**
- **1 BEM à 2 mois et 3 mois**
- **1 BEM à 6, 9 et 12 mois**
- **1 BEM à 2 ans et 3 ans**
- **1 BEM à 5 ans et ensuite tous les 5 ans**

INSUFFISANCE TRICUSPIDE et TRANSPLANTATION CARDIAQUE

ETIOLOGIE

IT après technique biatriale

MECANISMES PHYSIOPATHOLOGIQUES

- **Déformation / traction de l'anneau tricuspide**
- **Dilatation OD**
- **Contraction asynchrone de l'OD**

J Heart Lung Transplant 2008;27:247-252
Ann Cardiothorac Surg 2017;6:270-274

ETIOLOGIE

IT après technique biatriale

6763 TC adultes

Biatrial Versus Bicaval Orthotopic Heart Transplantation: A Systematic Review and Meta-Analysis

Technique biatriale
3555 (52.6%) patients

Technique bicavale
3208 (47.4%) patients

Ann Thorac Surg 2020;110:684-691

INSUFFISANCE TRICUSPIDE et TRANSPLANTATION CARDIAQUE

ETIOLOGIE

IT après technique biatriale

B **Early moderate-to-severe tricuspid regurgitation**

Model	Study name	Odds ratio	Lower limit	Upper limit	Z-Value	p-Value	TR / Total Biatrial	TR / Total Bicaval
	Deleuze PH, 1995	3.689	1.327	10.258	2.502	0.012	33 / 40	23 / 41
	Leyh RG, 1995	4.000	0.799	20.017	1.687	0.092	8 / 12	5 / 15
	Aziz T, 1999	1.698	0.883	3.266	1.586	0.113	31 / 105	19 / 96
	Milano CA, 2000	2.537	1.231	5.229	2.523	0.012	29 / 68	17 / 75
	Wang SS, 2000	5.250	1.624	16.974	2.770	0.006	27 / 39	6 / 20
	Solomon NA, 2004	7.394	0.369	148.300	1.308	0.191	3 / 38	0 / 37
	Koch A, 2005	1.275	0.749	2.169	0.895	0.371	37 / 139	35 / 158
	Sun JP, 2007	1.582	1.052	2.377	2.205	0.027	66 / 293	50 / 322
	Kalra N, 2010	1.557	0.250	9.689	0.474	0.635	55 / 57	53 / 56
	Kara I, 2012	7.077	2.147	23.329	3.215	0.001	23 / 28	13 / 33
	Wartig M, 2014	1.973	1.252	3.109	2.928	0.003	63 / 221	38 / 226
	Huenges K, 2016	1.086	0.333	3.548	0.137	0.891	21 / 108	4 / 22
	Rivinius R, 2017	0.664	0.356	1.241	-1.283	0.199	24 / 161	24 / 115
Random		1.915	1.376	2.665	3.855	0.000		

I-squared: 65.6%, Q-value: 34.929, df(Q): 12, P-value: <0.001

C **Early moderate-to-severe mitral regurgitation**

Model	Study name	Odds ratio	Lower limit	Upper limit	Z-Value	p-Value	MR / Total Biatrial	MR / Total Bicaval
	Grande AM, 2000	1.294	0.521	3.215	0.556	0.578	17 / 71	9 / 46
	Solomon NA, 2004	0.316	0.012	8.009	-0.698	0.485	0 / 38	1 / 37
	Koch A, 2005	2.307	0.993	5.358	1.944	0.052	17 / 139	9 / 158
	Sun JP, 2007	1.922	0.865	4.267	1.605	0.108	17 / 293	10 / 322
	Kara I, 2012	5.750	1.902	17.379	3.100	0.002	20 / 28	10 / 33
	Rivinius R, 2017	2.159	0.087	53.470	0.470	0.638	1 / 161	0 / 115
Random		2.129	1.312	3.455	3.060	0.002		

I-squared: 59.7%, Q-value: 14.889, df(Q): 6, P-value: 0.021

RESULTATS À COURT TERME

Ann Thorac Surg 2020;110:684-691

INSUFFISANCE TRICUSPIDE et TRANSPLANTATION CARDIAQUE

ETIOLOGIE

IT après technique biatriale

D **Early permanent pacemaker implantation**

Model	Study name	Odds ratio	Lower limit	Upper limit	Z-Value	p-Value	Biatrial	Bicaval
	Sarsam MAI, 1993	1.000	0.127	7.893	0.000	1.000	2 / 20	2 / 20
	Blanche C, 1994	19.286	1.109	335.503	2.031	0.042	12 / 64	0 / 40
	Laske A, 1995	4.333	1.150	16.323	2.167	0.030	13 / 20	6 / 20
	Brandt M, 1997	7.875	1.958	31.675	2.906	0.004	14 / 30	3 / 30
	Parry G, 1998	9.824	0.592	163.019	1.594	0.111	32 / 359	0 / 49
	Bainbridge AD, 1999	1.000	0.060	16.791	0.000	1.000	1 / 29	1 / 29
	Grande AM, 2000	7.692	0.415	142.501	1.370	0.171	5 / 71	0 / 46
	Wang SS, 2000	0.727	0.180	2.946	-0.446	0.655	6 / 39	4 / 20
	Solomon NA, 2004	2.364	0.854	6.541	1.657	0.098	15 / 38	8 / 37
	Kara I, 2012	5.556	1.348	22.901	2.373	0.018	10 / 28	3 / 33
	Markowicz-Pawlus E, 2012	3.857	0.771	19.293	1.644	0.100	12 / 40	2 / 20
	Sattiraju S, 2012	1.183	0.651	2.151	0.551	0.582	37 / 155	22 / 105
	Huenges K, 2016	2.381	0.291	19.462	0.810	0.418	11 / 108	1 / 22
	Ferretto S, 2017	0.225	0.012	4.395	-0.983	0.326	0 / 150	3 / 240
Random		2.487	1.464	4.226	3.370	0.001		

Statistics for each study — PM / Total — Odds ratio and 95% CI

I-squared: 41.0%, Q-value: 22.035, df(Q): 13, P-value: 0.055

A **Early mortality**

Model	Study name	Odds ratio	Lower limit	Upper limit	Z-Value	p-Value	Biatrial	Bicaval
	Blanche C, 1994	6.025	0.316	114.962	1.194	0.233	4 / 64	0 / 40
	Deleuze PH, 1995	1.986	0.718	5.492	1.322	0.186	13 / 40	8 / 41
	Aleksic I, 1996	10.593	0.558	201.013	1.572	0.116	4 / 60	0 / 66
	Bouchart F, 1997	1.045	0.294	3.706	0.068	0.946	9 / 65	4 / 30
	Aziz T, 1999	3.103	1.177	8.185	2.289	0.022	18 / 105	6 / 96
	Bainbridge AD, 1999	1.252	0.335	4.675	0.335	0.738	6 / 29	5 / 29
	Riberi A, 2001	0.775	0.346	1.735	-0.619	0.536	11 / 72	20 / 106
	Sun JP, 2007	1.419	0.634	3.177	0.850	0.395	14 / 293	11 / 322
	Kara I, 2012	3.840	0.376	39.186	1.135	0.256	3 / 28	1 / 33
	Huenges K, 2016	0.792	0.204	3.077	-0.337	0.736	12 / 108	3 / 22
Random		1.474	1.003	2.167	1.977	0.048		

Statistics for each study — Dead / Total — Odds ratio and 95% CI

I-squared: <0.001%, Q-value: 5.244, df(Q): 6, P-value: 0.513

RESULTATS À COURT TERME

Ann Thorac Surg 2020;110:684-691

INSUFFISANCE TRICUSPIDE et TRANSPLANTATION CARDIAQUE

ETIOLOGIE

IT après technique biatriale

Outcome	Variable	Biatrial (n = 3555)	Bicaval (n = 3208)	OR/RR (95% CI)	*P* Value	Studies Reported	I^2 (%)
Early	Mortality	12.5 (8.30 to 18.4)	8.80 (4.8 to 15.5)	1.47 (1.0 to 2.2)[a]	.048	10	4.7
	Tricuspid regurgitation	42.8 (30.8 to 55.7)	28.5 (20.2 to 38.6)	1.92 (1.4 to 2.7)[a]	<.001	13	52.6
	Mitral regurgitation	11.1 (3.6 to 29.7)	6.9 (2.4 to 17.9)	2.13 (1.3 to 3.5)[a]	.002	6	12.1
	Pacemaker implantation	19.2 (12.2 to 28.7)	8.6 (4.8 to 15.0)	2.49 (1.5 to 4.2)[a]	.001	14	34.8
Late	Mortality	4.9 (1.1 to 8.7)	4.1 (0.3 to 7.8)	1.77 (1.2 to 2.6)[b]	.004	4	0
	Tricuspid regurgitation	6.3 (3.9 to 8.6)	1.2 (0.5 to 2.0)	2.14 (1.2 to 3.9)[b]	.014	8	79.5
	Mitral regurgitation	0.4 (–0.4 to 1.3)	0.4 (–0.3 to 1.0)	1.23 (0.6 to 2.4)[b]	.528	6	0
	Pacemaker implantation	3.3 (1.3 to 5.4)	1.4 (2.0 to 2.5)	1.93 (0.9 to 4.1)[b]	.083	8	41.5

RESULTATS À LONG TERME

Ann Thorac Surg 2020;110:684-691

ETIOLOGIE

IT après technique biatriale

RESULTATS À LONG TERME

Ann Thorac Surg 2020;110:684-691

INSUFFISANCE TRICUSPIDE et TRANSPLANTATION CARDIAQUE

PRISE EN CHARGE CHIRURGICALE

Reference	IT sévère/TC	Etiologie	Chirurgie
Transplant Int 1992;5(suppl 1):S255-8	6/96 (6.3%)	après BEM 100%	3 PLT (**3.1%**)
Ann Thorac Surg 1994;57:832-7	20/183 (10.9%)	après BEM 60%	2 RVT (**1.1%**)
Ann Thorac Surg 1995;59:477-80	5/526 (**0.9%**)	après BEM 100%	3 PLT / 2 RVT
Transplant Int 1996;9(suppl 1):S247-8	12/505 (**2.4%**)	après BEM 100%	4 PLT / 8 RVT
J Heart Lung Transplant 2005;24:S227-31	25/101 (24.7%)	après BEM 100%	4 RVT (**3.9%**)
J Heart Lung Transplant 2006;25:289-93	8/138 (**5.7%**)	après BEM 50%	6 PLT / 2 RVT
J Heart Lung Transplant 2006;25:48-52	17/871 (**1.9%**)	après BEM 94.1%	16 RVT / 1 PLT

PRISE EN CHARGE CHIRURGICALE

Expérience lyonnaise

01/01/2014 - 31/12/2021
Transplantations cardiaques adultes n = 217

↓

Chirurgie tricuspide à distance
n = 2 (0.9%) + n = 4

↓

Age moyen 57.3 ± 13.5 ans
Sexe masculin 50%

3 PLT / 3 RVT
4 interventions à cœur battant

INSUFFISANCE TRICUSPIDE et TRANSPLANTATION CARDIAQUE

PRISE EN CHARGE CHIRURGICALE

Expérience lyonnaise

Chirurgie tricuspide à distance
Groupe PLASTIE TRICUSPIDE n = 3

#1

Femme - 64 ans

5 mois après TC

Traumatique après BEM

Prolapsus feuillet antérieur

Anneau + « Clover technique »

Suivi à 85 mois

NYHA I - IT modérée

#2

Homme - 64 ans

15 mois après TC

Traumatique après BEM

Prolapsus feuillet septal

Anneau + « Clover technique »

Suivi à 76 mois

NYHA I - IT minime

#3

Femme - 45 ans

21 ans après TC

Traumatique après BEM

Prolapsus feuillet septal

Anneau + « Clover technique »

Suivi à 45 mois

NYHA I - IT minime

INSUFFISANCE TRICUSPIDE et TRANSPLANTATION CARDIAQUE

PRISE EN CHARGE CHIRURGICALE

Expérience lyonnaise

The clover technique in endomyocardial biopsy-induced tricuspid regurgitation

M. Pozzi [a,*], I. Pavlakovic [b], A. Dondas [a], L. Sebbag [c], P. Boissonnat [c], J.F. Obadia [a]

Int J Cardiol 2016;203:731-732

INSUFFISANCE TRICUSPIDE et TRANSPLANTATION CARDIAQUE

PRISE EN CHARGE CHIRURGICALE

Expérience lyonnaise

Chirurgie tricuspide à distance
Groupe REMPLACEMENT VALVULAIRE TRICUSPIDE n = 3

#1

Homme - 61 ans

17 ans après TC

Secondaire + Sonde PM

Fusion sonde-feuillet septal

RVT bio + PM épicardique

Suivi à 39 mois

NYHA I - IT minime

#2

Femme - 73 ans

17 ans après TC

Secondaire + Sonde PM

Fusion sonde-feuillet antérieur

RVT bio + PM épicardique

Suivi à 37 mois

NYHA I - IT modérée

#3

Homme - 37 ans

19 ans après TC

Secondaire + BEM

Dilatation annulaire+++

RVT biologique

Suivi à 4 mois

NYHA I - IT minime

INSUFFISANCE TRICUSPIDE et TRANSPLANTATION CARDIAQUE

PRISE EN CHARGE CHIRURGICALE

Mortalité intra-hospitalière

Reference	IT sévère/TC	Etiologie	Chirurgie
Transplant Int 1992;5(suppl 1):S255-8	6/96 (6.3%)	après BEM 100%	3 PLT (**3.1%**)
Ann Thorac Surg 1994;57:832-7	20/183 (10.9%)	après BEM 60%	2 RVT (**1.1%**)
Ann Thorac Surg 1995;59:477-80	5/526 (**0.9%**)	après BEM 100%	3 PLT / 2 RVT
Transplant Int 1996;9(suppl 1):S247-8	12/505 (**2.4%**)	après BEM 100%	4 PLT / 8 RVT
J Heart Lung Transplant 2005;24:S227-31	25/101 (24.7%)	après BEM 100%	4 RVT (**3.9%**)
J Heart Lung Transplant 2006;25:289-93	8/138 (**5.7%**)	après BEM 50%	6 PLT / 2 RVT
J Heart Lung Transplant 2006;25:48-52	17/871 (**1.9%**)	après BEM 94.1%	16 RVT / 1 PLT

MORTALITE = 3.9% (2/51 patients)

INSUFFISANCE TRICUSPIDE et TRANSPLANTATION CARDIAQUE

PRISE EN CHARGE CHIRURGICALE

Mortalité intra-hospitalière (chirurgie tricuspide isolée)

National Trends and Outcomes in Isolated Tricuspid Valve Surgery

Chad J. Zack, MD,[a] Erin A. Fender, MD,[a] Pranav Chandrashekar, MBBS,[a] Yogesh N.V. Reddy, MBBS,[a] Courtney E. Bennett, DO,[a,b] John M. Stulak, MD,[c] Virginia M. Miller, PhD,[c,d] Rick A. Nishimura, MD[a]

MORTALITE = 8.8% (5005 patients)

Beating versus arrested heart isolated tricuspid valve surgery: An 11-year experience in the current era

Michele Flagiello MD | Daniel Grinberg MD[1] | Martin Connock PhD[2] | Xavier Armoiry PharmD, PhD[3,4] | Remi Buzzi MD[1] | Helene Thibault MD, PhD[5] | William Uhlrich MD[5] | Matthias Jacquet-Lagreze MD[6] | Jean L. Fellahi MD, PhD[6] | Jean F. Obadia MD, PhD[1] | Matteo Pozzi MD, PhD[1]

MORTALITE = 8.5% (88 patients)

Circulation 2009;120:1672-1678
J Thorac Cardiovasc Surg 2013;146:278-284
Interact Cardiovasc Thorac Surg 2014;18:27-32
J Cardiothorac Surg 2020;57:142-150

MORTALITE = 2-13%

INSUFFISANCE TRICUSPIDE et TRANSPLANTATION CARDIAQUE

TAKE HOME MESSAGE

3

L'IT est la valvulopathie la plus fréquente chez les patients greffés

Ann Cardiothorac Surg 2017;6:270-274

IT minime → 60% de patients
IT modérée-sévère → 40% de patients

J Heart Lung Transplant 2001;20:709-717

TAKE HOME MESSAGE

4

La majorité des IT après transplantation cardiaque sont traumatiques (BEM)

J Heart Lung Transplant 2008;27:247-252

Une intervention chirurgicale peut être nécessaire jusqu'à 6% de patients greffés

J Heart Lung Transplant 2006;25:289-293

Les résultats postopératoires sont satisfaisants (morbi-mortalité)

Ann Cardiothorac Surg 2017;6:270-274

INSUFFISANCE TRICUSPIDE et TRANSPLANTATION CARDIAQUE

PRISE EN CHARGE PERCUTANEE

Edge-to-edge tricuspid valve repair for severe tricuspid regurgitation 20 years after cardiac transplantation

ESC Heart Fail 2020;7:4320-4325

Percutaneous Tricuspid Valve Repair

A Promising Treatment for Heart Transplant Patients With Severe Tricuspid Regurgitation

JACC Case Rep 2021;3:1269-1274

PREVENTION

1) **Annuloplastie tricuspide prophylactique ???**

   Healthcare (Basel) 2021;9:306-318

2) **AlloMap**

   J Heart Lung Transplant 2019;38:51-58

Merci pour votre attention

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