

LES TROUBLES DU RYTHME et CHIRURGIE DES CARDIOPATHIES CONGENITALES

PREVENTION CHIRURIGICALE
TRAITEMENT CHIRURGICAL

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3 situations chirurgicales distinctes

- Eviter création de troubles du rythme séquellaires consécutifs à la chirurgie
- Proposer une chirurgie antiarythmique adaptée concomitante à la réparation de la cardiopathie avec trouble du rythme avéré
- Proposer une prophylaxie des troubles du rythme au moment de la réparation de la cardiopathie congénitale

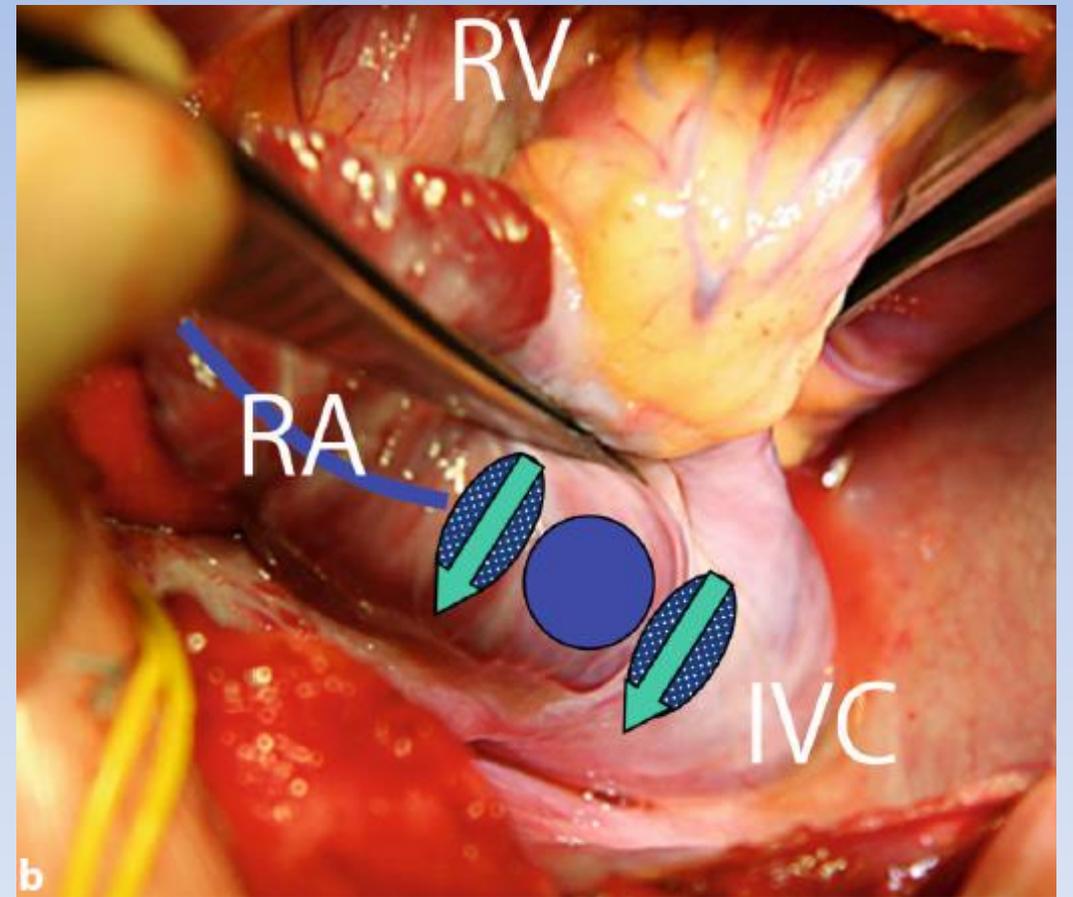
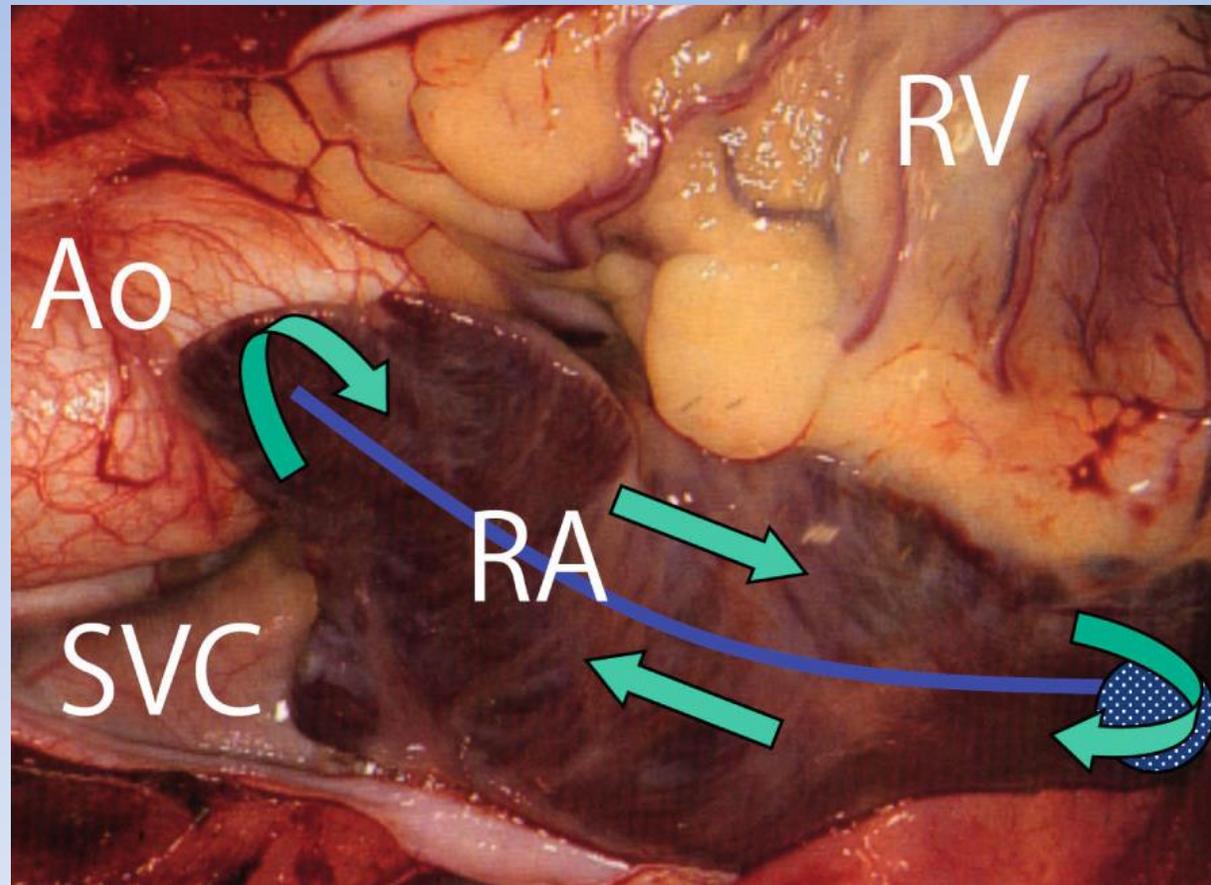
PREVENTION CHIRURGICALE

Eviter la g n se de troubles du rythme

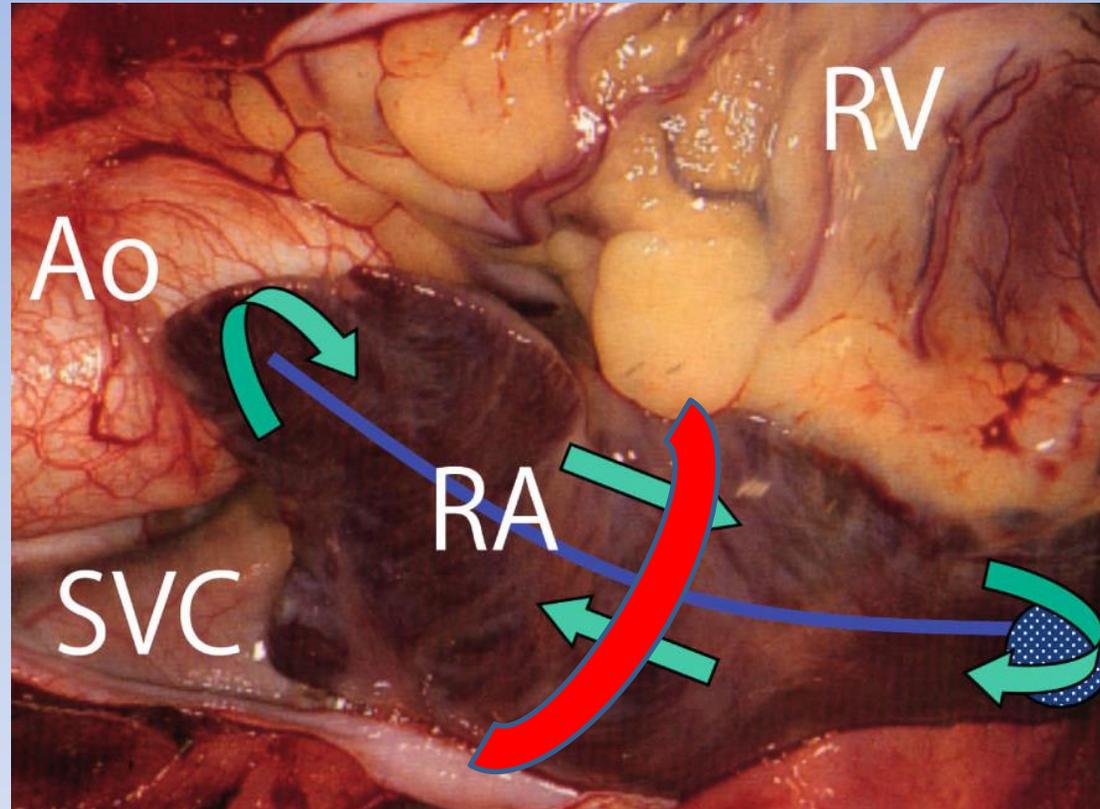
Auriculaire

Ventriculaire

Chirurgie = lésions arythmogènes



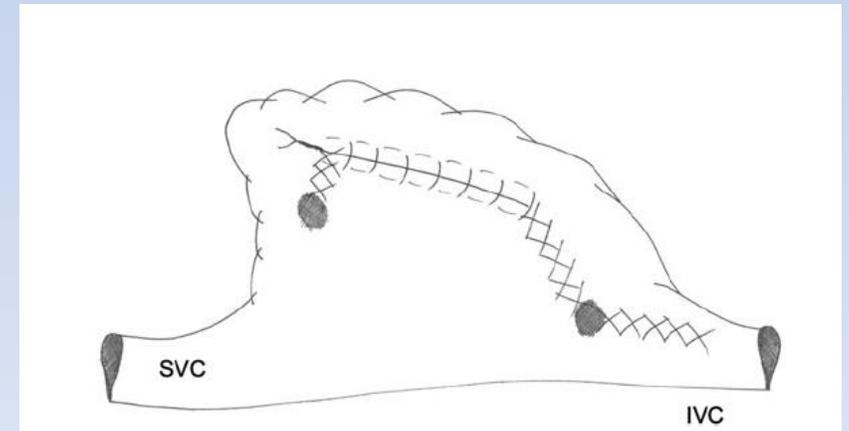
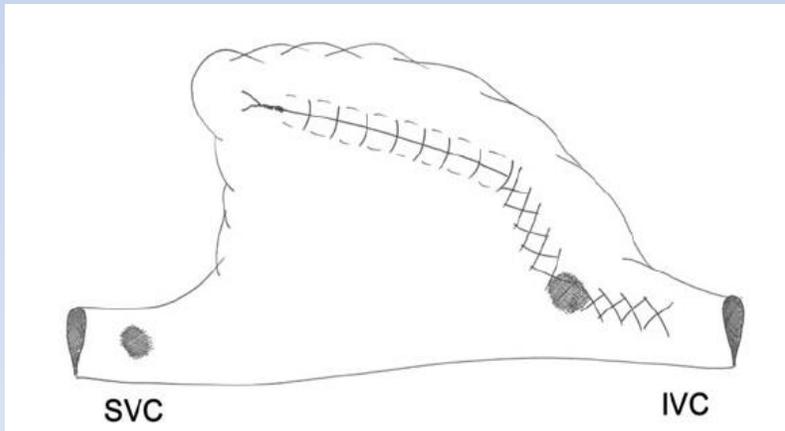
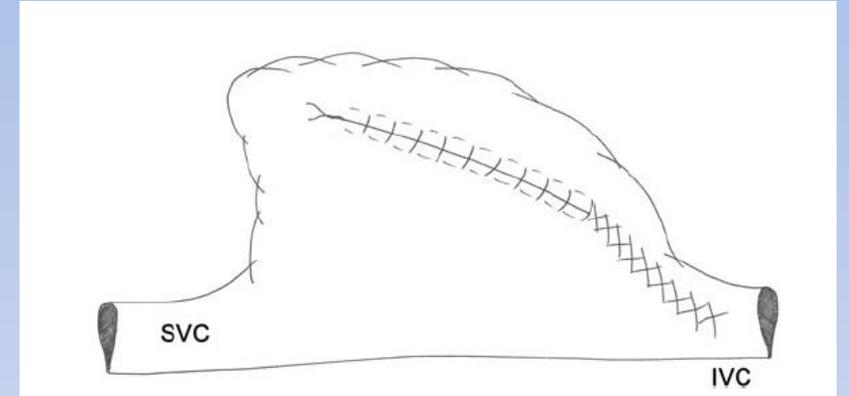
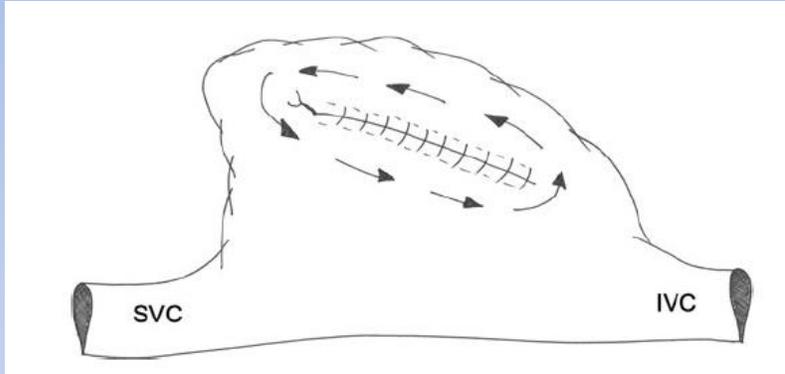
Chirurgie = lésions arythmogènes



Possibilité technique de limiter risque mais au détriment de l'accès

Henglein, Cardiol Young,
1999

Stratégie préventive



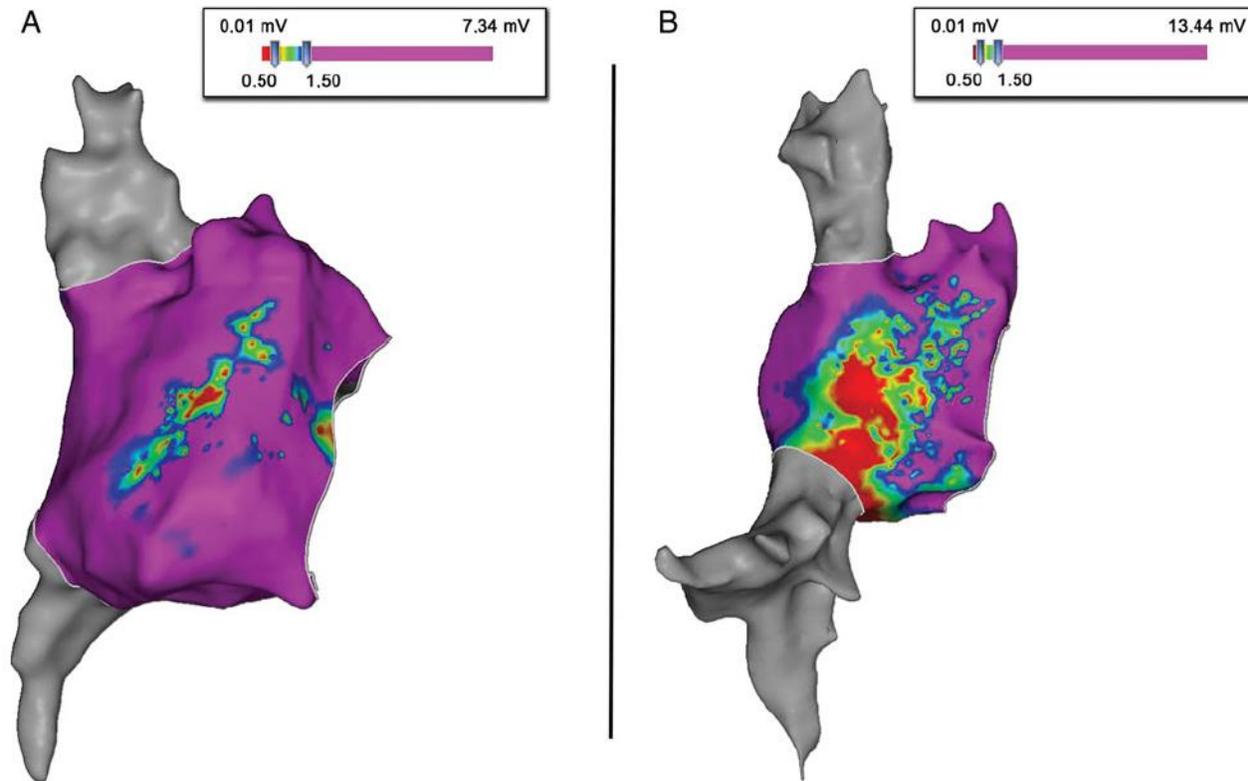


Figure 6: Colour-coded voltage maps of the right atrium of two patients after surgery involving right atriotomy. Purple represents normal voltages. Red, green and blue represent very low voltages (red represents zero voltage), i.e. scars. (A) After a right atriotomy without the proposed suture line. There are clearly normal voltages all around the atriotomy scar. (B) Right atriotomy with the addition of the proposed suture line. It can be seen that there is a continuous scar on the right atrial wall, extending down to the IVC.

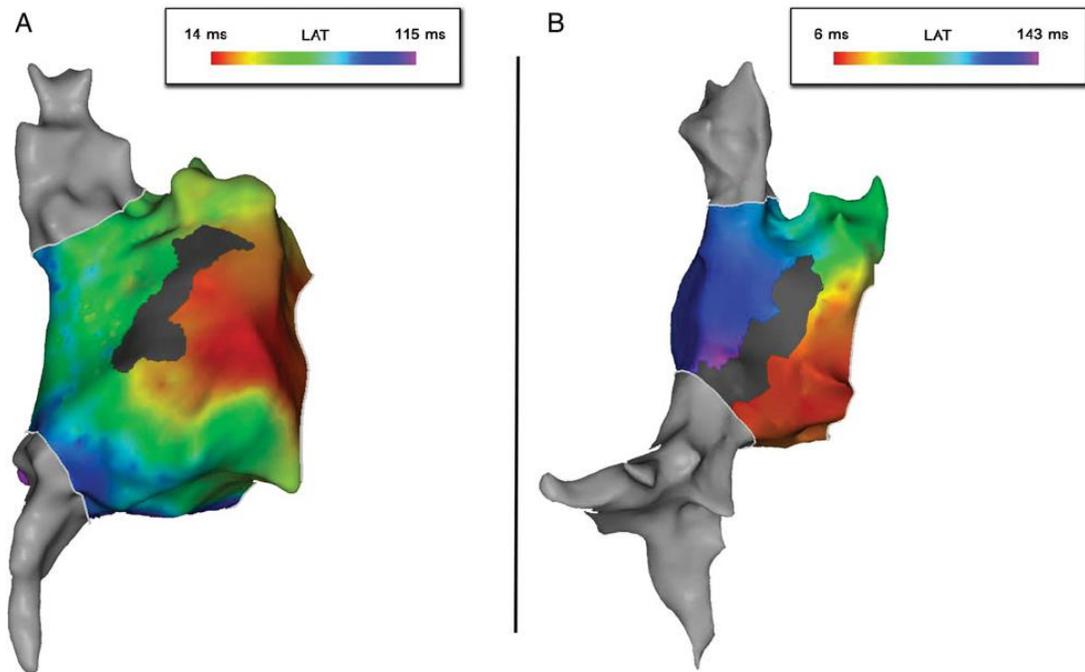
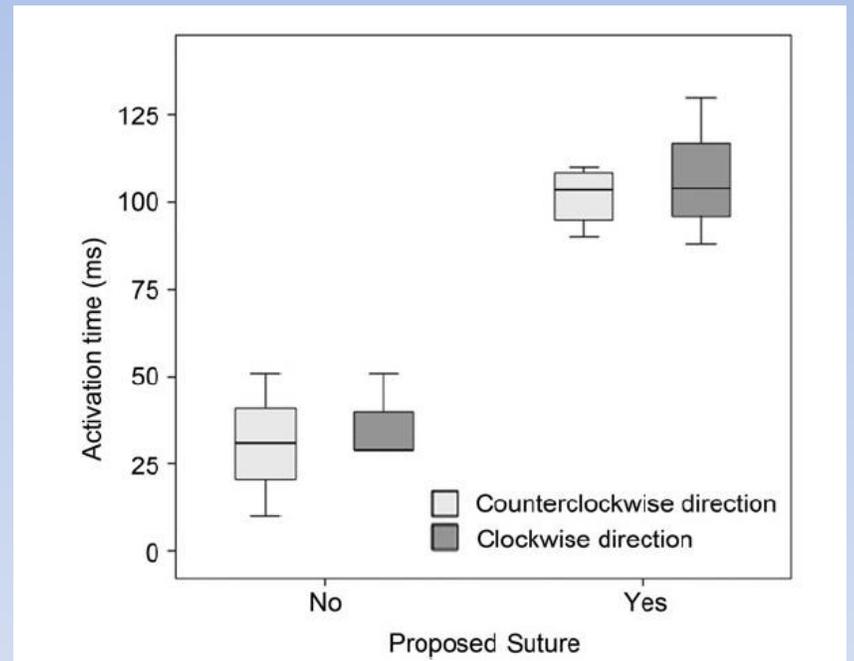


Figure 7: Colour-coded activation maps of the right atrial wall, with the stimulation electrode positioned anteriorly. These were arbitrarily colour-coded in the following sequence: red-orange-yellow-green-blue-purple. Thus, the area that is closest to the stimulation electrode (and therefore activated first) appears red; the farthest area (and therefore activated last) appears purple. By following this colour sequence, we can see the exact trajectory of the wave front. Areas of no activation (scars) were coded dark grey. **(A)** Atriotomy without the addition of the proposed suture line. The atriotomy scar is easily seen (dark grey). The colour code sequence shows that there is clearly unhindered propagation of the wave front around both ends of the atriotomy scar. **(B)** Atriotomy with the addition of the proposed suture line. There is a continuous scar (dark grey) from and including the atriotomy down to the IVC. The colour sequence shows that the wave front cannot cross this; it propagates around the cephalad end of the atriotomy scar and reaches the other side of the added suture line last (small purple area). LAT: latent period between signal generation by the stimulation electrode, and its detection by the mapping electrode, measured in milliseconds.



LES TROUBLES DU RYTHME AVERES

FREQUENCE

GRAVITE

Anomalies morphologiques et Arythmies

Table 1

Reoperation rates and estimated prevalence of arrhythmias in adults with congenital heart disease

| Congenital Heart Disease | Reoperation (%) | Atrial Arrhythmias (%) | Ventricular Tachycardia (%) |
|--|------------------------|-------------------------------|------------------------------------|
| ASD | <2 | 16–50 | <2 |
| Ebstein anomaly | 30–50 | 33–60 | >2 |
| Single ventricle | >25 | >40–70 | >5 |
| TOF | 26–50 | 12–43 | 10–15 |
| Transposition of the great arteries, atrial switch | 15–27 | 26–50 | 7–9 |
| Transposition of the great arteries, arterial switch | 12–20 | <2 | 1–2 |
| Congenitally corrected transposition of the great arteries | 25–35 | >30 | >2 |
| Truncus arteriosus | 55–89 | >25 | >2 |
| Atrioventricular septal defect | 19–26 | 5–10 | <2 |

Modified from Khairy P, Van Hare GF, Balaji S, et al. PACES/HRS Expert Consensus Statement on the recognition and management of arrhythmias in adult congenital heart disease. Heart Rhythm 2014;11:e35; with permission.

PREVENTION SECONDAIRE CONGENITAUX ADULTES

Troubles du rythme atrial:

- fonction ventriculaire, statut fonctionnel, survie
- 50% mortalité, ×2 AVC et IC, ×3 réopérations

Controverses des 20 dernières années

- Maze bilatéral versus maze droit ou gauche isolé (isoler veines pulmonaires)
- Maze par section-suture versus cryothérapie ou radiofréquence
- Maze intracardiaque (clantage aortique) versus extracardiaque (cœur battant)

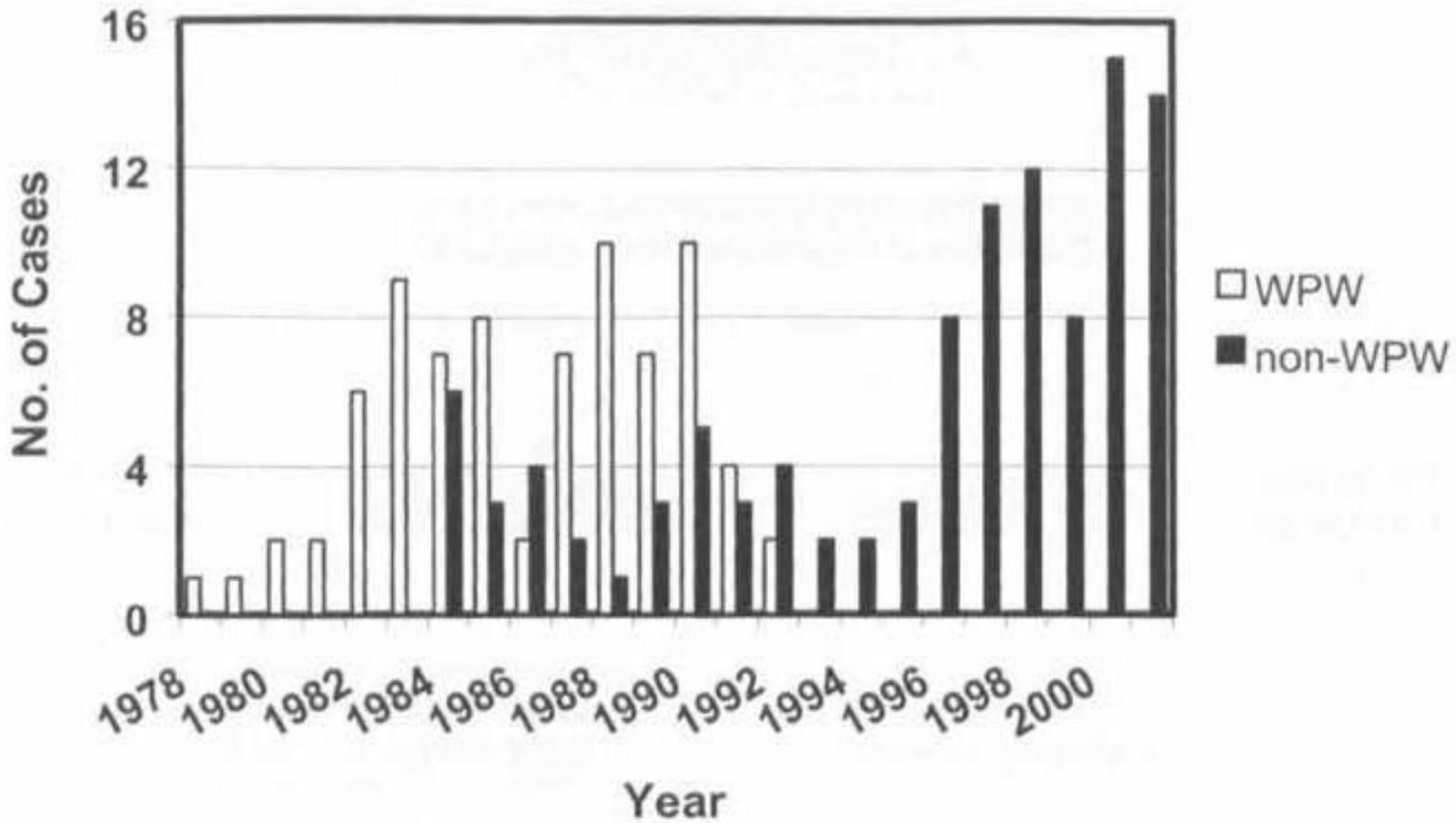
Plus efficace, moins invasif

- Mais surtout:

Places respectives: traitement chir / ttt cathétérisme

Chir: échec ou difficultés KT, anatomie complexe, épaisseur de la paroi atriale, circuits multiples, difficultés d'accès veineux, nécessité de réduction atriale, FA

Opposition: caractère invasif, bilan électro-physiologique continu



Facteurs de risque de troubles du rythme

Table 2
Risk factors for arrhythmia development in congenital heart disease

Supraventricular Tachycardia

Older age at initial repair
QRS duration >160 ms
Longer duration of follow-up
Reoperation for hemodynamic abnormalities does not eliminate SVT
Prior atrial surgery
Loss of sinus rhythm
Preoperative arrhythmias
Residual hemodynamic problems

Ventricular Tachycardia

Older age at initial repair
QRS duration >180 ms
Longer duration of follow-up
Reoperation for hemodynamic problems may decrease risk of VT
Residual hemodynamic problems
RV hypertension
Pulmonary regurgitation
Cardiomegaly
LVEF <40%

Abbreviation: LVEF, left ventricular ejection fraction.

Les différentes interventions en fonction du trouble rythmique

Table 3
Operative techniques for arrhythmia surgery

| Type of Arrhythmia | Surgical Techniques |
|---------------------------------|--|
| Supraventricular | |
| Accessory connection | Endocardial or epicardial dissection and division; cryoablation |
| Focal AT | Map-guided resection; cryoablation |
| AV nodal reentrant tachycardia | Slow pathway modification with cryoablation |
| RA macro-reentry | |
| Cavotricuspid isthmus dependent | Cavotricuspid isthmus ablation |
| Multiple reentrant circuits | Modified right atrial maze |
| Left atrial macro-reentry | |
| AF | Left atrial Cox-maze III lesions with cavotricuspid isthmus ablation ± right atrial maze ± left atrial appendectomy |
| VT | |
| Scar related | Scar or endocardial fibrosis resection; focal ablation; lines of ablation between anatomic landmarks; map-guided resection or ablation |



Guidelines: une grande prudence une absence de preuve

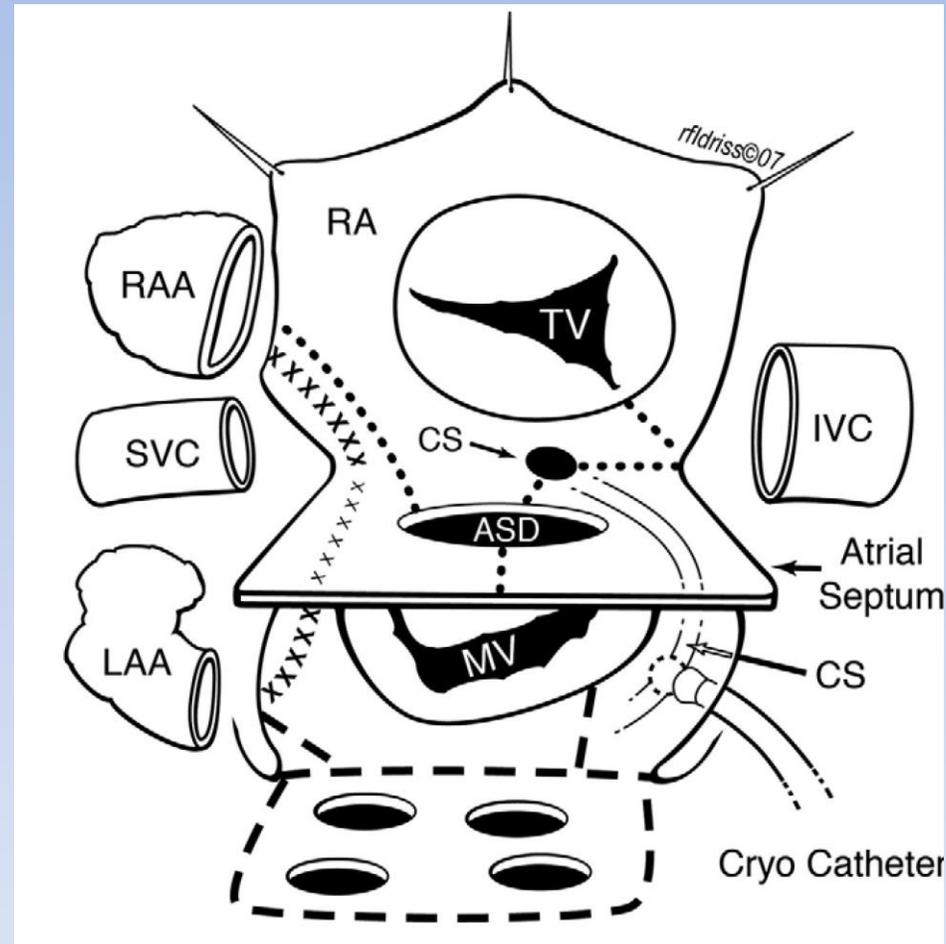
| Table 4 Consensus statements and guideline recommendations for surgical treatment of arrhythmias | | |
|---|-------------------|---|
| Class of Recommendation | Level of Evidence | Recommendation |
| 2014 PACES/HRS Consensus statement for arrhythmia management in ACHD | | |
| I | B | A modified right atrial maze procedure is indicated in adults undergoing Fontan conversion with symptomatic right atrial IART |
| I | B | A modified right atrial maze procedure in addition to a left atrial Cox maze III procedure is indicated in patients undergoing Fontan conversion with documented AF |
| IIa | B | Concomitant atrial arrhythmia surgery should be considered in adults with Ebstein anomaly undergoing cardiac surgery |
| IIa | B | A (modified) right atrial maze procedure can be useful in adults with CHD and clinical episodes of sustained typical or atypical right AFL |
| IIa | B | A left atrial Cox maze III procedure with right atrial cavotricuspid isthmus ablation can be beneficial in adults with CHD and AF |
| 2014 ACC AHA Guidelines for the management of AF | | |
| IIa | C | An AF surgical ablation procedure is reasonable for selected patients with AF undergoing cardiac surgery for other indications |
| IIb | B | A stand-alone AF surgical ablation procedure may be reasonable for selected patients with highly symptomatic AF not well managed with other approaches |
| 2016 ACC AHA Guidelines for the management of SVT in adults | | |
| I | C-LD | Assessment of associated hemodynamic abnormalities for potential repair of structural defects is recommended in ACHD patients as part of therapy for SVT |
| IIa | B-NR | Preoperative catheter ablation or intraoperative surgical ablation of accessory pathways or AT is reasonable in patients with SVT who are undergoing surgical repair of Ebstein anomaly |
| IIa | B-NR | Surgical ablation of AT or AFL can be effective in ACHD patients undergoing planned surgical repair |

| Table 4 (continued) | | |
|-------------------------|-------------------|---|
| Class of Recommendation | Level of Evidence | Recommendation |
| III | C | Prophylactic arrhythmia surgery is not indicated in adults with CHD at increased risk of surgical mortality from ventricular dysfunction or major comorbidities, in whom prolongation of cardiopulmonary bypass or cross-clamp times owing to arrhythmia surgery might negatively impact outcomes |
| III | C | Empiric ventricular arrhythmia surgery is not indicated in adults with CHD and no clinical or inducible sustained VT |

Abbreviations: ACC, American College of Cardiology; AHA, American Heart Association; CHD, congenital heart disease; HRS, Heart Rhythm Society; IART, intra-atrial reentrant tachycardia; LD, limited data; NR, nonrandomized; PACES, Pediatric And Congenital Electrophysiology Society.

Reproduced from Refs. ^{8,39,64}; with permission.

Maze droit – Maze gauche



Fonction de la pathologie initiale

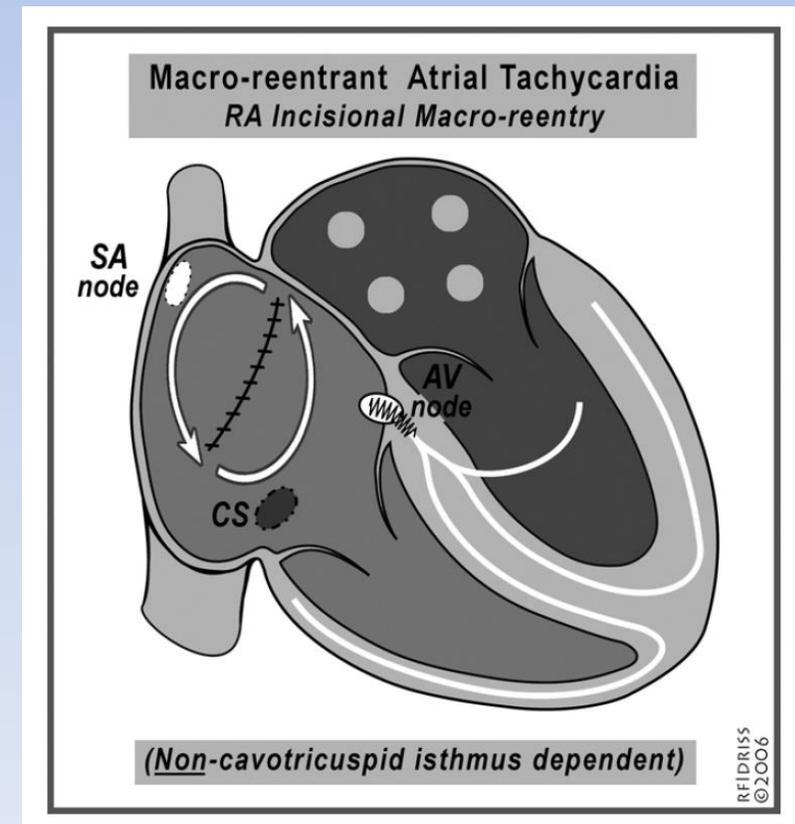
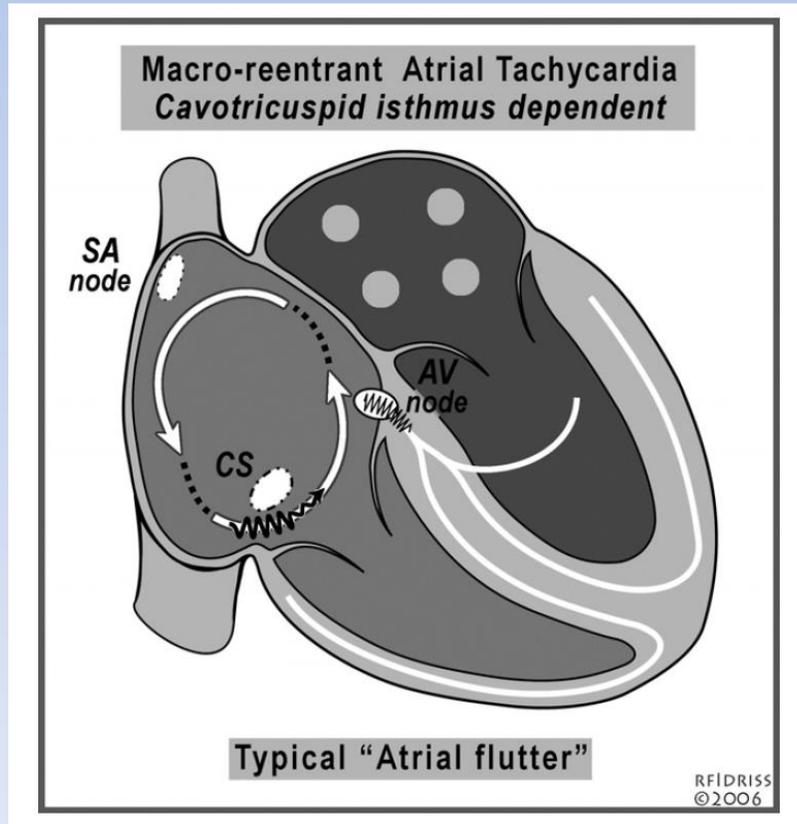
Table 5

Lesion sets for surgical treatment of atrial tachycardia associated with congenital heart disease

| Congenital Heart Disease | Type of Arrhythmia at Risk | Lesion Set |
|---------------------------------|--|--|
| Ebstein anomaly | Atrial reentry, large right atrium | Cavotricuspid isthmus ablation; atrial reduction |
| | Atrial reentry, large right and left atria | Cavotricuspid isthmus ablation; atrial reduction, left atrial maze |
| | Accessory connections | Endocardial or epicardial dissection; cryoablation |
| Univentricular hearts | Atrial reentry | Modified right atrial maze (see Fig. 1) ⁶⁸ |
| | AF | Left atrial maze plus modified right atrial maze |
| ASD | AF | Left atrial maze (see Fig. 2) ⁶⁹ |
| TOF | Atrial reentry | Cavotricuspid isthmus ablation or modified right atrial maze |

Ventricule unique

Electrophy preoperatoire imperative



Création physique des lésions

Section suture

Radiofréquence

Cryoablation

Avantages et Inconvénients de chaque technique

Ventricle Unique

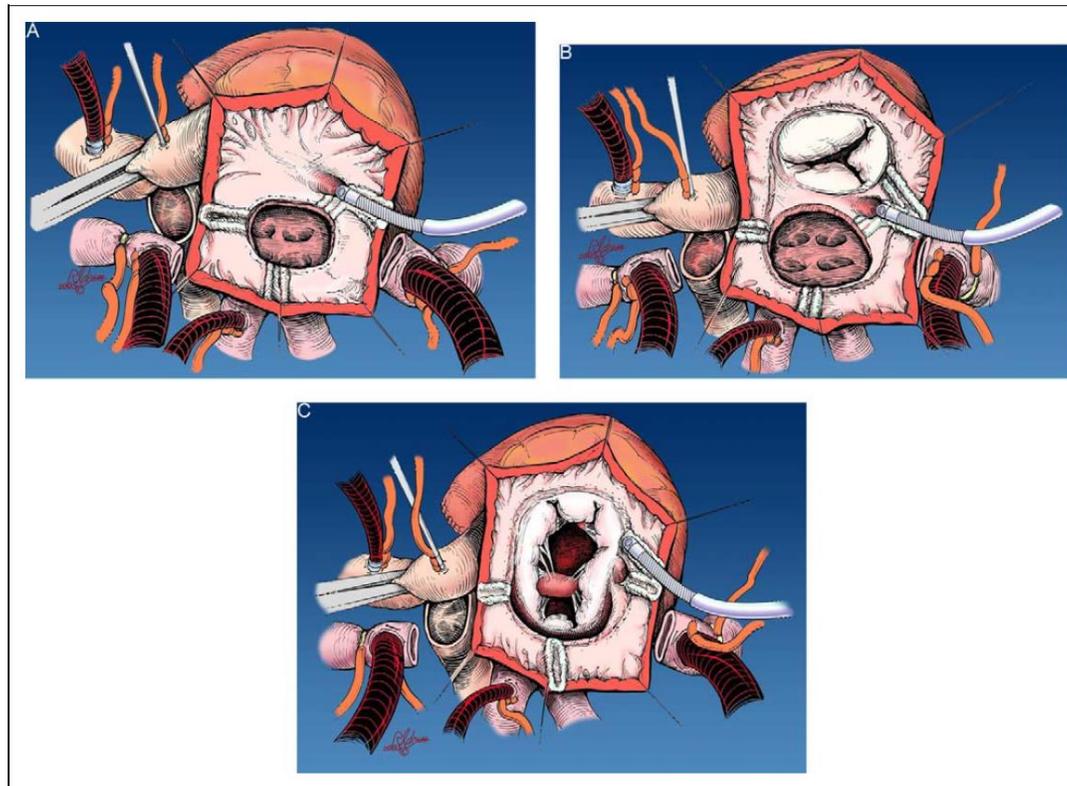


Figure 6. A, The modified right-sided maze procedure in a patient with tricuspid atresia. B, The modified right-sided maze procedure in a patient with double outlet right ventricle and mitral atresia. C, The modified right atrial maze procedure in patients with a single ventricle and unbalanced atrioventricular canal. Reproduced with permission from Mavroudis et al.²⁶

MAZE en FONCTION du TYPE de VENTRICULE

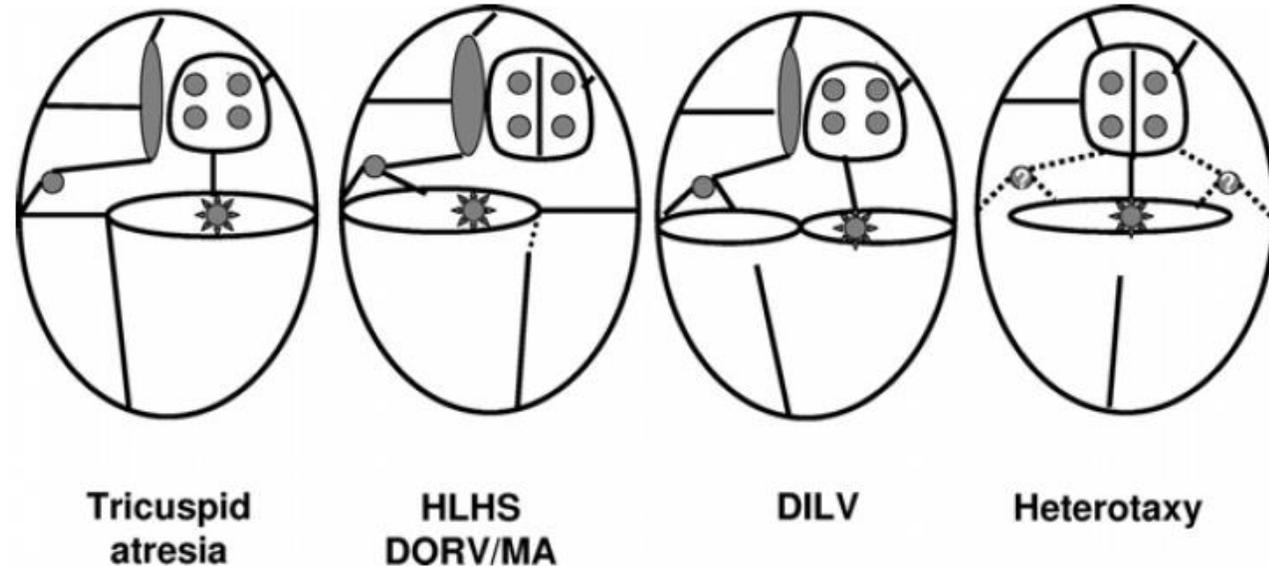


Table 1 Fontan Conversion: Surgical Steps

- Resect enlarged right atrium
- Extracardiac Gore-tex tube graft (24 mm) IVC to pulmonary artery
- Bidirectional superior cavopulmonary anastomosis
- Right maze \pm Cox-maze III
- Epicardial pacemaker (DDD)

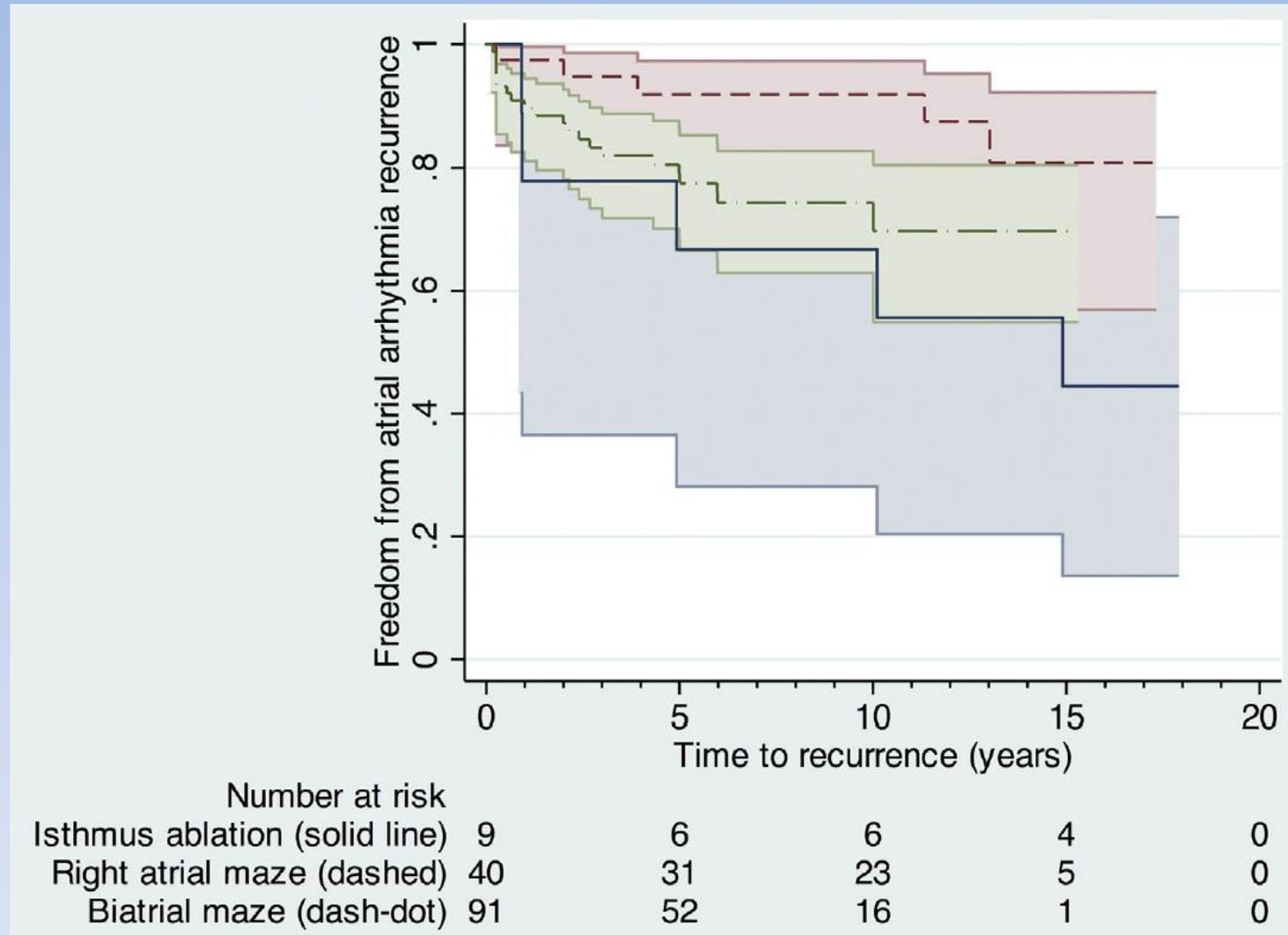
RESULTATS

Facteur de risque de décès

- Maze biatrial
- CEC > 240 minutes

Pas de récurrence: 77% à 10 ans

Pas de récurrence de FA pour biatrial



« PROPHYLAXIE »

Problématique complexe

- Pas de certitude d'apparition des troubles du rythme => Evaluer une sous-population de congénitaux à risque élevé
- Quel type de chirurgie anti-arythmique proposer? Droit, gauche, biatrial?
- Quel type d'énergie utiliser?
- Traiter les auricules?

Balance Risques/Bénéfices

Pas d'arythmie à 18 ans => 50% à 65 ans

Quelles pathologies concernées?

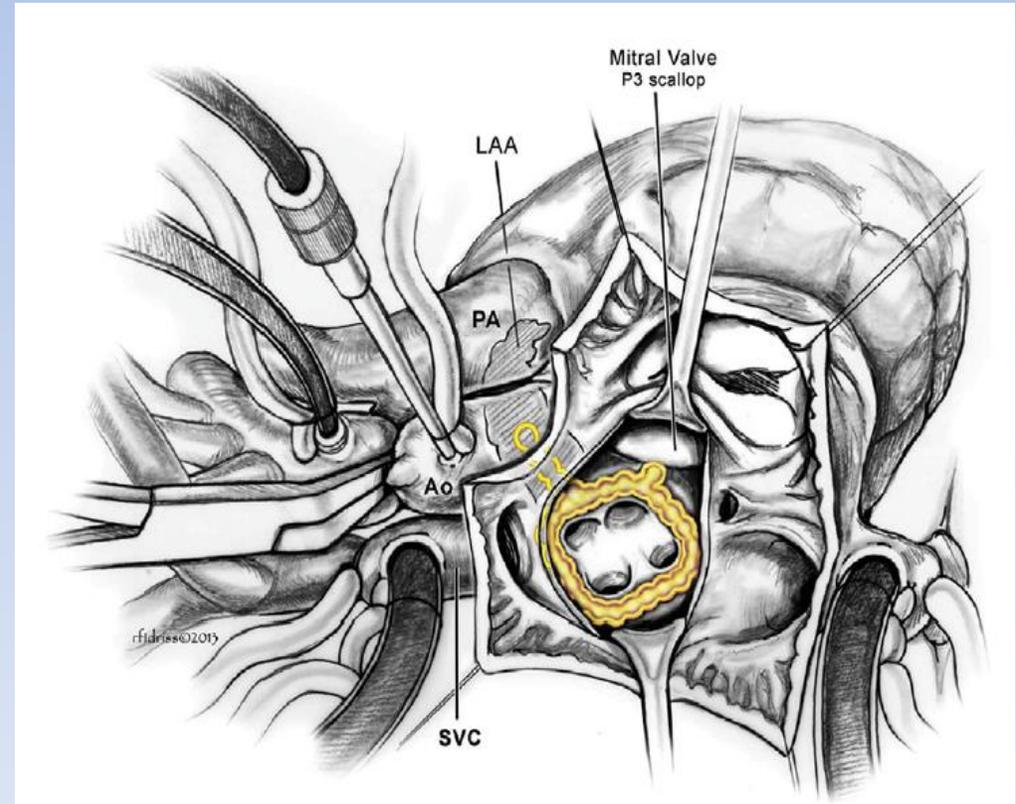
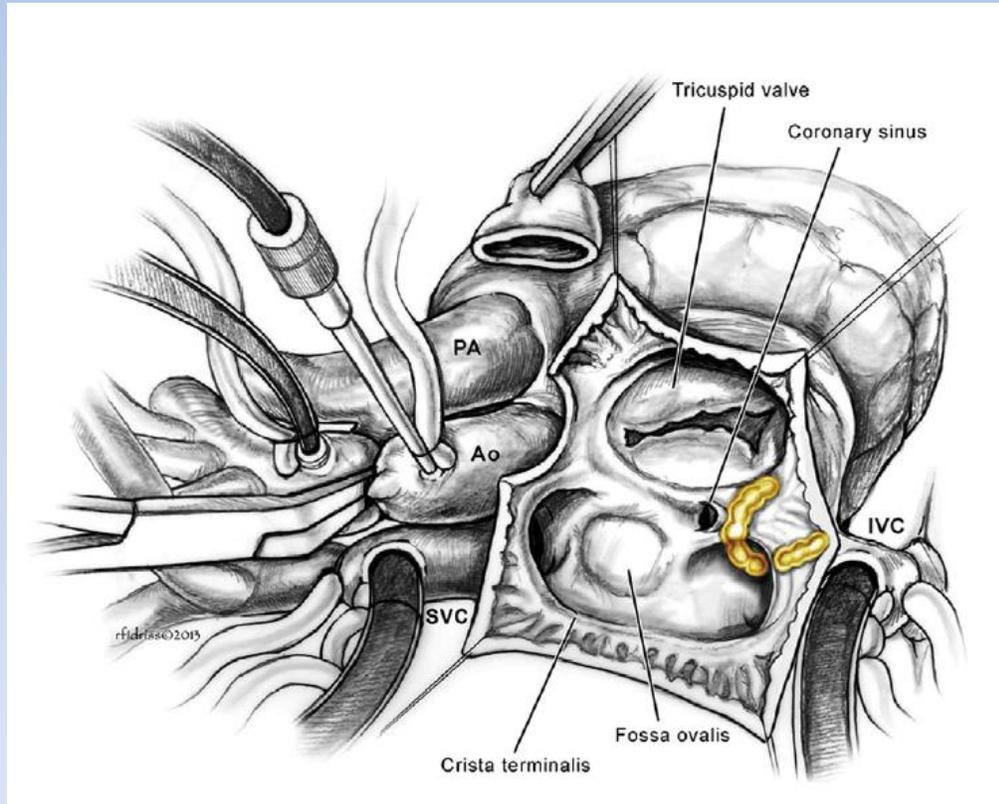
- Ebstein
- Ventricule unique
- CIA
- Fallot

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Quelle lésion faut il créer? Efficacité / risque opératoire



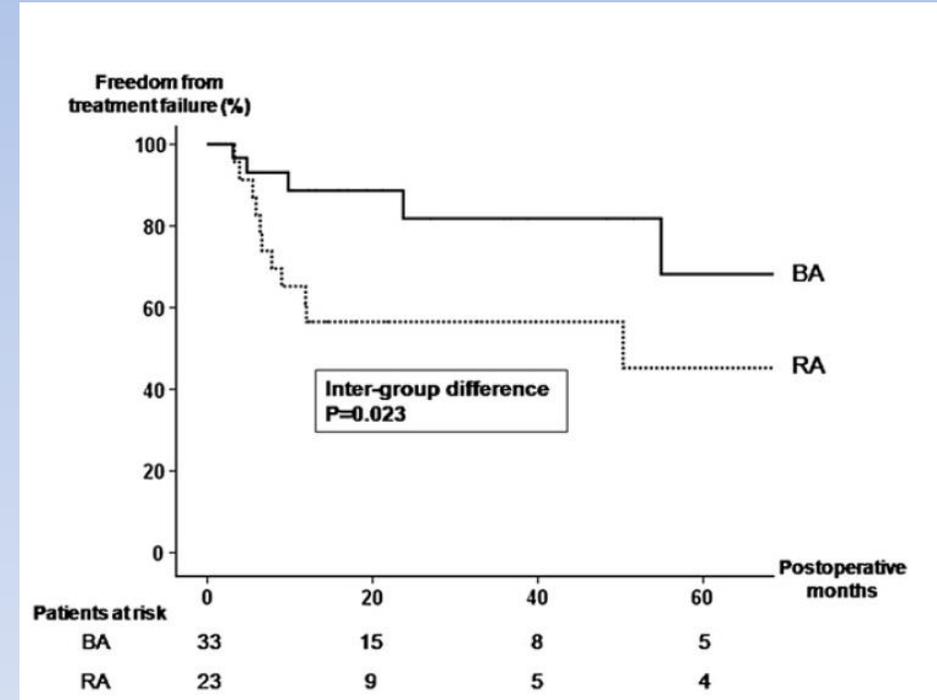
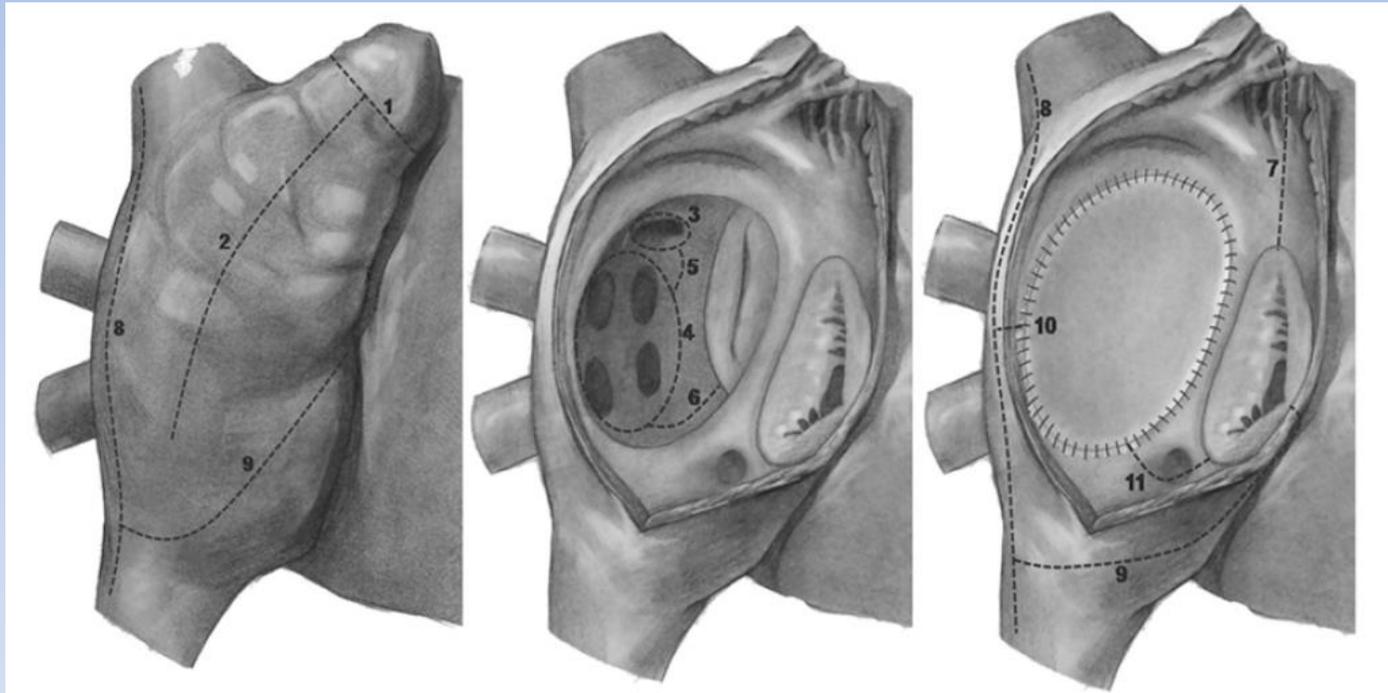
Chir prophylactique

Des propositions....

Table 1. Suggested Prophylactic Lesion Sets For Patients With Specific Congenital Heart Disease

| Congenital Heart Disease | Type of Arrhythmia at Risk | Prophylactic Lesion Set | Timing of Procedure |
|--------------------------|---------------------------------|-------------------------|--|
| Ebstein's anomaly | ART, large right atrium | see Fig 1 | Primary repair in patients without arrhythmias; most reparative operations performed in adolescents and adults |
| | ART, large right and left atria | see Fig 2 | Primary repair in patients without arrhythmias; not enough data to recommend prophylactic operations in neonates and infants |
| Univentricular hearts | ART | see Fig 1 | Primary repair Fontan operation in patients without arrhythmias |
| Atrial septal defect | Atrial fibrillation | see Figs 1 and 2 | Patients > 40 y without arrhythmias |
| Tetralogy of Fallot | ART | see Fig 1 | Reoperation for older patients without arrhythmias |

Complexité / bénéfice



RECURRENCE DES TROUBLES DU RYTHME

Stratégie d'anticipation

1. Laisser/créer voie d'accès pour traitement percutané ultérieur (fenestration, CIA)
2. Implantation pacemaker épicardique

CONCLUSION

- RCP: rythmologue pour staff de GUCH
- Bilan électrophysiologique préopératoire
- Laisser des accès de traitement endovasculaire
- Stratégie de complémentarité pré/post op

L'électro-physiologie est au chirurgien,
ce que les supra-conducteurs sont à l'électricien:
un gigantesque trou noir

Hommage à Stephen Hawking....