Reimplantation Should Be Preferred

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Reimplantation vs Remodeling

07.45  Case presentations
        Live operations: Moderation M. De Bonis
08.00  Case #1
09.30  Case #2
      BREAK
11.00  Failures after aortic valve repair  D. Aicher
11.30  Case #3
12.45  Discussion of the cases
      BREAK
13.00  Reimplantation should be preferred  L. de Kerchove
13.15  Remodeling should be the standard  H.-J. Schäfers
14.00  3-dimensional echo in aortic valve repair  A. Hagendorff
14.30  How to start root repair  H.-J. Schäfers
      BREAK
15.30  Wetlab (bring your loupes!)  Faculty
18.00  Adjourn
VSRR: The Origin

Remodeling technique (1983)  
Reimplantation technique (1992)

Sir M. Yacoub  
T. David
VSRR: Initial enthusiasm for both techniques (Reimpl – Remod)

Stanford 1993
Hopkins 1997
Harrefield 1983
Lubeck 1993
Hannover 1993
Brussels 1996

Kari F.A. Circ 2013
**VSRR: Doubt on Remodeling?**

Remodeling

- Faster
- Less root dissection
- Only 1 suture line

Reimplantation

- More hemostatic
- Annuloplasty
VSRR: Doubt on Remodeling

1979-1997: 158 patients

89% @10y
85% @15y

1979-1998: 82 Marfans

M.H. Yacoub JTCVS 1998
E.J. Birks. Circ 1999
VSRR: Doubt on Remodeling

- Stanford 1993
- Hopkins 1997
- Toronto 1992
- Harrefield 1983
- Hannover 1993
- Lubeck 1993
- Brussels 1996
- 1988-2005: 220 patients

T. David JTCVS 2006
N. de Oliveira JTCVS 2003
(Fig 1). We started with the T. David-I operation and then tried the Yacoub technique in the late 1990s; even though the remodeling approach is quicker and saves one suture line, one reoperation due to annular dilatation and recurrent AR prompted abandoning the Yacoub approach after 12 adult cases. We then reverted to the T. David-IV technique, and in May 2001 (the same month Dr David independently but similarly began using a larger graft necked down both proximally at the annulus and distally at the sinotubular junction) adopted the T. David-V method.

C. Miller ATS 2007
**Conclusions.** Aortic root replacement in children with aneurysms has low operative risk and good long-term results. Composite grafts in particular carry a low risk of endocarditis, thromboembolism, and hemorrhagic events. Homografts are suitable for small patients but lack durability. Late results with the David II remodeling valve-sparing procedure in children have been compromised by late root dilatation.

Conclusions—The high failure rate of aortic root remodeling inpatients with acute type A aortic dissection is discouraging. Whether this technique should be applied in acute type A aortic dissection is questionable. In contrast, aortic root reimplantation lead to favorable midterm outcome. Thus, we recommend consideration of this technique for surgical treatment of patients with acute type A aortic dissection. *(Circulation. 2002;106[suppl I]:I-229-I-233.)* R.G. Leyh
VSRR: Doubt on Remodeling

- Toronto 1992
- Hopkins 2002
- Harrefield 1983
- Lubeck 1993
- Hannover 1993
- Brussels 2001

Log-rank test (Cox-Mantel) p=0.145

<table>
<thead>
<tr>
<th>Remodeling</th>
<th>96</th>
<th>21</th>
<th>6</th>
</tr>
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<tbody>
<tr>
<td>At risk</td>
<td>68</td>
<td>9</td>
<td>9</td>
</tr>
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</table>

97.8±2.2%

88.6±4.4%

A.W. Erasmi ATS2007
VSRR: Lack of annuloplasty in Remodeling

- Harrefield 1983
- Toronto 1992
- Stanford 2001
- Hopkins 2002
- Lubeck 1993
- Hannover 1993
- Brussels 2001

- Hanke T., Sievers H.J. JTCS 2009:
  - 191 VSRR, 76% TAV
  - 56% Remodeling
VSRR: While the world was almost bleu and in peace...

Two “irreducible Gallic”
VSRR: The rational for Remodeling

- Snapshot, close to native AV dynamics in VSRR does not mean durability!
- Lack of annuloplasty seems to be a much stronger predictor of durability

Conclusions: In vitro the various aortic valve-sparing operations differed characteristically in their ability to spare valve function, none of them completely meeting native valve behavior. The remodeling techniques exhibited valve dynamics closest to those of the native aortic root. The more the aortic valve is fixed with noncompliant prosthetic material, the more the native root dynamics are impaired.
VSRR: Lack of annuloplasty in Remodeling

Kunihara T., Schäfers H.J. JTCVS 2012

- 430 VSRR, 70% TAV,
- 93% Remodeling
VSRR: Annuloplasty in Reimplantation

**BAV**

FF AR >1+  

p = 0.93

**TAV**

FF AR >1+  

p = 0.4

---

VSR VAJ <28mm  

p = 0.38

---

VSR VAJ ≥28mm  

p = 0.0001

---

VSR VAJ <28mm  

VSR VAJ ≥28mm  

p = 0.4

---

VSR VAJ <30mm  

VSR VAJ ≥30mm  

p = 0.4

---

Navarra E. EJCTS 2013  

De Kerchove L. EJCTS 2015
VSRR: Longest term results of Reimplantation vs Remodeling

1988-2010: 371 patients (296 Reimpl – 75 Remod)

T. David JTCVS 2014
VSRR: Longest term results of Reimplantation vs Remodeling

1988-2012: 146 Marfans
(121 Reimpl – 25 Remod)

1988-2012: 146 Marfans
(69 Reimpl – 29 Remod)

T. David JACC 2015

J. Price JTCVS 2016
VSRR: Evolution of the Remodeling technique

- Reimplantation
- Circumferential external band
- Suture Annuloplasty

But...
- Operative time!
- Root dissection!
- AV dynamics?
- Improve durability?

E. Lansac 2006 (started in 2003)
H.J. Schäfers 2013 (started 2008)
VSRR: Doubt on the Reimplantation technique

	n→ Risk of cusp damage and rapid deterioration of the valve!

✓ Only very occasionally reported, incidence?
  Do not induce clinically significant impact

✓ Max valve opening
✓ coronary vascularisation
✓ “Stress less” opening/closure
VSRR: Evolution of the Reimplantation technique

Reimplantation

David V

Stanford Modification

C. Miller

Valsalva®

Cardioroot®

Uni-Graft®

R. De Paulis 2002

Sinus Graft
VSRR: Why Reimplantation should be preferred

- Safe and reproducible, disseminated worldwide
- Proven durability up to 15y in TAV, BAV, Marfans and dissection
- One sizing, one device (graft) (≠ Remodeling + annuloplasty)
  → Costs of the procedure!
- Ability to modify valve geometry (from asymmetric BAV to 180° symmetric configuration) (≠ Remodeling ± annuloplasty)
VSRR: **Why Reimplantation should be preferred**

But, excellent long term durability can be achieve in Reimplantation only if

- Technical pitfalls avoided (sizing, commissure resuspension)
- Appropriate cusp management

**Central Cusp Plication**

*Schäfers HJ. JTCVS 2006*

*Aicher D. Circ. 2011*
VSRR: *Whatever the technique you choose, do a Reimplantation!*
Thank you
VSRR: How to do it?

Central Cusp Plication

El Khoury G.

Schäfers HJ. JTCVS 2006

Aicher D. Circ. 2011
VSRR: How to do it?

Pethig K. ATS 2002

Tips < annulus, Residual AR, Coapt < 4 mm

Tips > annulus, No AR

Tips > annulus
Residual AR, Coapt > 4 mm

Tips < annulus

Cusp Repair!

Cusp Repair!
VSRR: How to do it?

- Rate of cusp repair in VSRR

**TAV**
- El Khoury 53% Reimplantation
- David ≈ 60% mixte
- Schäfers ≈ 90% Remodeling

**BAV**
- El Khoury 95% Reimplantation
- Schäfers ≈ 95% Remodeling
- Miller 66% Reimplantation

**Graphs**
- **AR 0-1+**, **AR 2+**, **AR 3+**
- **1 cusp**, **2 cusps**, **3 cusps**
- **RCC**, **LCC**, **NCC**
VSRR: How to do it? Brussels Technique

1. Valve inspection
2. Root dissection
3. Complex cusp repair
4. Graft sizing & proximal suture line
5. Com. reimplantation & distal suture line
6. Residual prolapse repair
7. Coronary reimplantation
VSRR: How to do it? Brussels Technique

1. Valve inspection

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7. Coronary reimplantation
1. Valve inspection

2. Root dissection

3. **Complex cusp repair**

4. Graft sizing & proximal suture line

5. Com. reimplantation & distal suture line

6. Residual prolapse repair

7. Coronary reimplantation
1. Valve inspection
2. Root dissection
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4. **Graft sizing & proximal suture line**
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VSRR: How to do it? Brussels Technique

1. Valve inspection
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VSRR: How to do it? Brussels Technique

Post-repair TEE
VSRR: Why and How to do it?

Conclusions

- VSRR is **SAFE, DURABLE, EXC. LT. SURVIVAL & FEW VRE (< Bentall)**

  in TAV, BAV but also **Marfan** and **AAD**

  with *Reimplantation* and with *Remodeling* techniques

  *Condicio sine qua non*

  ANNULOPLASTY & CUSP REPAIR!
VSRR: The Literature

- Birks EJ., Yacoub MH. Circulation. 1999
- De Olievera NC., David TE. JTCVS 2003
- Miller DG. JTCVS 2003
- Bethea BT., Cameron D. ATS 2004
- David T. JTCVS 2006
- Erasmi A., Sievers HH. ATS 2007

Suggest better repair durability with the Reimplantation technique.
AV Repair: Leaflet repair in valve sparing surgery

Cusp repair = risk factor of reoperation or recurrent AR

- E. Lansac EJCTS 2010 (negative impact of cusp repair decrease with experience)
- P.P. Urbanski EJCTS 2012
Valve sparing root replacement

$\text{a} = \text{STJ}$

$\text{a}' = \text{graft size}$

$\text{Remodeling} \quad \text{Reimplantation}$

Prolapse level?
VSRR: Why to do it?

Hospital mortality

12% AAD • 1% (4/371 pts Reimpl. & Remod.)  
T. David JTCVS 2014

8% AAD • 2% (6/747 pts Remodeling)  
H-J Schäfers EJCTS 2015

10% AAD • 2% (4777 pts Metanalysis)  
B. Arabkhani ATS 2015

Elective • 0.3% (1/381 pts Reimplantation)  

6% AAD • 0.7% (1/146 Marfan Reimpl. & remod.)  
T.David JACC 2015

4% AAD • 0% (0/98 Marfan Reimpl. & remod.)  
J. Price JTCVS 2016

1. SAFE!
VSRR: Why to do it?

Freedom from Reoperation

Reimpl. & Remod.

Overall 95%@ 18 y

Reimplantation

Overall 95%@ 12 y

Remodeling

Overall 91%@ 15 y

T. David JTCVS 2014

H-J Schafers EJCTS 2015

S. Mastrobuoni STSA 2014

2. Durable!
### VSRR: Why to do it rather than Bentall?

<table>
<thead>
<tr>
<th>VSRR</th>
<th>Bentall</th>
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<tbody>
<tr>
<td><strong>Pooled Late Outcome Events</strong></td>
<td><strong>LOR + 95% CI</strong></td>
</tr>
<tr>
<td>Late mortality</td>
<td>1.53 (1.19−1.96)</td>
</tr>
<tr>
<td>Reoperation on aortic valve</td>
<td>1.32 (1.0−1.74)</td>
</tr>
<tr>
<td>Hemorrhage</td>
<td>0.23 (0.13−0.42)</td>
</tr>
<tr>
<td>Thromboembolism</td>
<td>0.41 (0.22−0.77)</td>
</tr>
<tr>
<td>Endocarditis</td>
<td>0.23 (0.11−0.51)</td>
</tr>
<tr>
<td>MAVRE</td>
<td>1.66 (1.24−2.23)</td>
</tr>
</tbody>
</table>

3. **Exc. LT. Survival!**

4. **Few VRE!**

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B. Arabkhani, JJ. Takkenberg ATS 2015
A. Mookhoek, JJ. Takkenberg ATS 2016
VSRR: How to do it?

David Operations

Kari F.A. Circ 2013
VSRR: How to do it? Brussels Way

Graft Sizing: *N/L com height* method
AV repair
Aorta/Annuloplasty repair strategy

AV repair for AR

Normal Root (<45 mm)
- Normal VAJ (<26 mm)
  - Subcom. Anpl.
- Large VAJ (>26 mm)
  - Ring Annuloplasty

Dilated Root (≥45 mm)
- Large VAJ (>26 mm)
  - Modify valve geometry
- VS Reimplantation
VSRR: How to do it?

- Birks EJ., Yacoub MH. Circulation. 1999
- De Olievera NC., David TE. JTCVS 2003
- Miller DG. JTCVS 2003
- Bethea BT., Cameron D. ATS 2004
- David T. JTCVS 2006
- Erasmi A., Sievers HH. ATS 2007

Suggest better repair durability with the Reimplantation technique
Predictors of AR recurrence

Coaptation height

Bierbach B.O. EJTC 2010

Aicher D. Circulation; 123:178-85, 2011
AV repair:
Probability of Cusp Repair in valve sparing surgery

- No AR → low 10%
- AR, central jet → Moderate 30-50%
- AR, eccentric jet → High ≈ 100%
Effect of VAJ size on AV repair durability

✓ Kunihara T., Schäfers H.J. JTCS 2012:
  • 430 VSRR, 70% TAV,
  • 93% remodeling

![Graphs showing the effect of VAJ size on AV repair durability.](image)
VSRR: How to do it?

- Remodeling

Graph showing the relationship between remodeling and aortic regurgitation grade. Equations for different remodeling sizes:
- 34 mm: $f(t) = 0.426 - 0.127t$
- 30 mm: $f(t) = 0.442 - 0.052t$
- 26 mm: $f(t) = 0.458 - 0.008t$

Statistical analysis:
- $P < 0.001$

- AVJD ≤ 28 mm:
  - 97.7 ± 0.9%
  - 95.6 ± 1.5%

- AVJD > 28 mm:
  - 87.5 ± 4.0%
  - 63.0 ± 10.3%

- Patients at risk:
  - AVJD ≤ 28 mm:
    - 336
    - 186
    - 65
  - AVJD > 28 mm:
    - 94
    - 41
    - 12

Hanke T. JTCVS 2009
Kunihara T. JTCVS 2012
VSRR: Outcomes of historical cohort

1979-1997: 158 patients
- 89% @10y
- 85% @15y

1979-1998: 82 Marfans

1988-2010: 371 patients
(296 Reimpl – 75 Remod.)
- 95% @18y

1988-2012: 146 Marfans
(121 Reimpl – 25 Remod.)

M.H. Yacoub JTCVS 1998
E.J. Birks. Circ 1999

T. David JTCVS 2014
T. David JACC 2016
VSRR: Why to do it in Marfan syndrome?

**Survival**

- VSRR
- Bentall

**Freedom from TE/Bleeding event**

- VSRR

**Freedom from Reoperation**

- VSRR 93% @ 10 y
- Bentall 92% @ 10 y

*J. Price JTCVS 2016*
VSRR: Why to do it in Marfan syndrome?

Freedom from Reoperation

5% reop @ 15 y

Freedom from AI >2+

Overall 8% @ 15 y
VSRR: Remodeling+annuloplasty long term result

✓ Lansac E., EJCTS 2006:

- 87 pts, 95% TAV
- 100% Remodeling, 60% with ring annuloplasty
- Less early residual or recurrent AI in Remodeling + ring group

✓ Aicher D., JTCS 20013:

- 559 BAV repair
- 193 (34%) VAJ suture annuloplasty in patient VAJ >27 mm
- Less early residual or recurrent AI in annuloplasty group