ROTATIONAL ATERECTOMY

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INTERVENTIONAL CARDIOLOGIST
“KYANOS STAYROS” EUROMEDICA
THESSALONIKI

Hellenic Institute of Cardiovascular Diseases
www.e-Cardio.gr
David Auth first described rotational ablation in 1986 as a technique for winding up coronary thrombus at low rotational speeds, thus capturing it on the rotating burr and shaft.

So what has happened since the introduction of rotational ablation?

We began with great enthusiasm for a technique unlike Gruentzig’s balloon, but the initial hope for a lower restenosis rate due to lack of barotrauma and vessel dissection was not corroborated by the DART, the ERBAC, the STRATAS or CARAT trials or a meta-analysis of multiple trials published by Bittl.
The initial tide of enthusiasm was then supplanted by a severe decrease in the rate of utilization of this procedure almost to the point where emerging fellows from interventional training programs are reluctant to use the Rotablator, since they have had minimal exposure to it.

By 2003–2004, the rate of rotational atherectomy use in the U.S. as reported by the ACC-NCDR and in Europe was ≤ 5%.
The Dark Side of Adjunctive Rotational Atherectomy

- **Cost** (It is an expensive device)
- Time
- **Technically challenging** (There is the myth of a “difficult” procedure)
- **Training** (Rotablation has a learning curve)
- Need familiarity with device and experienced operator
- Complications
- Injury Extension and Geographical Miss
- RCT’s were not able to proof any advantage of Rotablation versus POBA (ERBAC[1997], SPORT[2000], ARTIST[2001])
High-speed rotational atherectomy with the Rotablator system has an unique characteristic compared with other atherectomy devices.

- It removes plaque by abrading the atherosclerotic material, producing millions of microparticles which are smaller than red blood cell.

- These microparticles are dispersed into the distal coronary circulation and are cleared by reticulo-endothelial system in liver, lung, and spleen.
According to this principle, the burr preferentially abrades hard (inelastic) tissue while sparing soft (elastic) tissue which can deflect away from the advancing rotating abrasive burr.

Helpful analogies:
- Shaving
- A nail file

Differential cutting means the ability to remove hard (inelastic) tissue while sparing soft (elastic) tissue which can deflect away from the advancing rotating abrasive burr.

Differential atherectomy
Orthogonal displacement of friction

Provides easy passage of the burr through tortuous and diseased segments of the coronary tree.

✓ Friction is minimized by a sliding motion perpendicular or orthogonal to the contact surface.

✓ The faster something is turned the more the friction is reduced.

Removal of cork from wine bottle. If a cork is twisted as it is pulled, the friction is reduced and the cork can be withdrawn easily.

Helpful analogies
- Removing a cork from a champagne bottle
- Taking a ring off a finger
Rotablator: Benefits

- Minimises vessel wall stretch and elastic recoil
- Eliminates vessel barotrauma
- Removes all plaque morphologies; *Soft, fibrotic, calcified*
- Produces a smooth lumen channel for improved hemodynamic flow
- Facilitate stent delivery and expansion

*post-PTCA procedure*  
*post-Rotablator® procedure* (with minimal vessel injury)
Hardware Components Overview

- Console
- DynaGlide™ foot pedal
- Compressed air or nitrogen
- Tank, regulators, attachments
Disposable Components Overview

Advancer

Burr catheter

WireClip™ Torquer & Guidewires

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Catheter
• 135 cm in length
• Sheath is .058”/1.473mm

Burr
• Elliptical shaped with 2,000 to 3,000 microscopic diamond crystals on the distal edge. The proximal surface of the burr is smooth
• The brass burr is nickel coated
• The diamond crystals are 20 microns in size, with only 5 microns extruding from the nickel coating
• Various sizes: 1.25, 1.5, 1.75, 2.0, 2.15, 2.25, 2.38, 2.5 mm
**Burr Size and Guide Selection**

- Guide catheter with side holes
- Guide catheter that provides coaxial engagement will reduce unfavorable guidewire bias
- Guide catheter to accommodate the final burr size to be utilized

### Recommended Curves*

<table>
<thead>
<tr>
<th>Mm</th>
<th>Burr diameter Inches</th>
<th>Recommended guide catheter (French)</th>
<th>Minimum ID required (Inches)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.25</td>
<td>0.049</td>
<td>6.0</td>
<td>0.060</td>
</tr>
<tr>
<td>1.50</td>
<td>0.059</td>
<td>6.0</td>
<td>0.063</td>
</tr>
<tr>
<td>1.75</td>
<td>0.069</td>
<td>7.0</td>
<td>0.073</td>
</tr>
<tr>
<td>2.00</td>
<td>0.079</td>
<td>8.0</td>
<td>0.083</td>
</tr>
<tr>
<td>2.15</td>
<td>0.085</td>
<td>8.0</td>
<td>0.089</td>
</tr>
<tr>
<td>2.25</td>
<td>0.089</td>
<td>9.0</td>
<td>0.093</td>
</tr>
<tr>
<td>2.38</td>
<td>0.094</td>
<td>9.0</td>
<td>0.098</td>
</tr>
<tr>
<td>2.50</td>
<td>0.098</td>
<td>9.0</td>
<td>0.102</td>
</tr>
</tbody>
</table>

**Recommended Curves**

<table>
<thead>
<tr>
<th>Left</th>
<th>Right</th>
</tr>
</thead>
<tbody>
<tr>
<td>Q. Curve®</td>
<td>FR4</td>
</tr>
<tr>
<td>CLS™</td>
<td>Multi-purpose</td>
</tr>
</tbody>
</table>

* Avoid abrupt primary and secondary curves.

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The guidewire placement plays an important role in the efficiency of debulking.
Rotawire™ Floppy and Extra Support Guide Wire

- Flexible and torque able to enhance navigation
- Significantly reduced guidewire bias
- Short Spring Tip (2.2cm)
- Light rail support

- Spring Tip (2.8cm)
- Lead wire for those physicians requiring a “stiffer” wire

A stiffer GW dose not always produce an unfavorable bias but sometimes makes favorable bias which may help a sufficient ablation of angulated heavily calcified lesion.

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In cases where the rotawire cannot be advanced, past the lesion a conventional angioplasty wire with an exchange microcatheter can be used. The rotawire can be advanced and positioned distally.

*** Finish the intervention on a normal wire
Advancing the burr

- **Nonactivated burr** advancement-reaching the platform segment

- **Activated burr advancement**
  To reach the platform segment, low-speed (100-120000 rpm) can be used to minimize ablation. The whole system can be advanced by defeating the brake and holding the wire.

- **Dynaglide is not recommended for advancement** because the rotational speed does not fall when resistance is met.

Dynaglide is a control that sets the rotation speed of the rotablator at 50,000-90,000 rpm and is used for reducing friction when removing the device.
Ablating Technique

Proper: Slow/Smooth/Short

Feedback During Ablation

- **Visual**
  - Smooth advancement under fluoroscopy
  - Contrast injection to discern lesion contours and borders
- **Auditory**
  - Pitch changes relative to resistance encountered by burr
- **Tactile**
  - Advancer knob resistance
  - Excessive drive shaft vibration: excessive load on burr advanced too rapidly

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What is my concept of “rotablating a lesion”

To debulk plaque?

or

To modify plaque?
Different protocols for rotational atherectomy have been investigated in an attempt to obtain the highest acute and at long-term success rate with the lowest risk of procedural complications.

**Particular attention has been paid to:**

- Burr size (burr to artery ratio)
- Rotablation speed
- Motion pattern of the burr
Burr selection is dependent on the treatment strategies with Rotablator.

- **PRIMARY THERAPY:** Maximal safe debulking with no further adjunctive treatment. **Burr/Artery ratio 0.75-0.85/1**

- **LESION MODIFICATION:** Improving lesion/vessel characteristics (compliance) in order to allow adjunctive technologies (DCA, PTCA, Stent). **Burr/Artery 0.6-0.7/1**
The atherectomy speed must be approximately 140,000 rpm, although there is no clear cut-off and some operators use 150,000 rpm. (may be beneficial for the reduction of slow flow or no reflow)

The higher the rotational speed, the more platelets are activated

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Motion pattern of the burr

Do not push the rotablator into the lesion. The intermittent application of RotA within lesion is preferred; Use “Pecking” technique

“Pecking” technique is used, where the burr is moved forward and backward the lesion, avoiding crossing the entire lesion during the initial passage

“Pecking” motion prevents “trenching” into arterial wall, allows wire to reposition as vessel compliance changes with debulking

Time of runs 15“

Intermittent pull back for coronary perfusion and/or contrast injection
Routine strategy (plaque modification) is better than aggressive debulking.

<table>
<thead>
<tr>
<th>Results:</th>
<th>Routine</th>
<th>Aggressive</th>
</tr>
</thead>
<tbody>
<tr>
<td>Procedural results:</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Max. Burr size (mm)</td>
<td>1.8mm</td>
<td>2.1mm</td>
</tr>
<tr>
<td>Burr/artery ratio</td>
<td>0.71</td>
<td>0.82</td>
</tr>
<tr>
<td>Burrs used</td>
<td>1.9</td>
<td>2.7</td>
</tr>
<tr>
<td>Acute results:</td>
<td></td>
<td></td>
</tr>
<tr>
<td>final MLD</td>
<td>1.97</td>
<td>1.95mm</td>
</tr>
<tr>
<td>residual stenosis</td>
<td>26%</td>
<td>27%</td>
</tr>
<tr>
<td>clinical success</td>
<td>93.5%</td>
<td>93.9%</td>
</tr>
<tr>
<td>CK-MB rise &gt;5 x nl</td>
<td>7%</td>
<td>11%</td>
</tr>
<tr>
<td>6 month results:</td>
<td></td>
<td></td>
</tr>
<tr>
<td>TLR</td>
<td>22%</td>
<td>31%</td>
</tr>
<tr>
<td>MLD</td>
<td>1.26mm</td>
<td>1.16mm</td>
</tr>
<tr>
<td>loss index</td>
<td>0.54</td>
<td>0.62</td>
</tr>
<tr>
<td>angiographic restenosis</td>
<td>52%</td>
<td>58%</td>
</tr>
</tbody>
</table>
Bigger burrs may debulk more of the lesion but they also may damage/activate more blood cells.

Starting with smaller burrs reduces the plaque burden to the distal bed and a patent lumen is achieved in a shorter period of time.

A RotA technique with 2 burrs may be chosen in order to reduce the incidence of the no-reflow phenomenon. The smaller burr (usually 1.25 mm) is used first, followed by a larger burr based on the size of the vessel, aiming at a burr/vessel ratio that does not exceed 0.6-0.7. However sometimes a single small burr is sufficient.
CARAFE STUDY PILOT
Cocktail Attenuation of Rotational Ablation Flow Effects
Virtually eliminates “Slow Flow” and “No-Reflow” phenomenon when used with current technique modification:

- During RotA, 500 ml of heparinised (5000 units) normal saline solution with 5 mg verapamil and 1000 μg nitroglycerine is administered locally, with a view to preventing thrombus formation and vascular spasm, and avoiding the no-reflow phenomenon.
During the ablation, excessive deceleration (more than 5,000 rpm) must be avoided because it results in improper ablation and increases the risk of vessel injury, the formation of large particles, and ischemic complications related to excessive heat generation.
Other cautions in Ablating Technique

- Avoid rapid advancement, dottering, force
- Avoid stopping or starting the burr in the lesion
- Avoid stopping burr distal to lesion
- Avoid adjusting rpm's during ablation
- Avoid the burr to remain in one location while rotating at high speeds

- Avoid burring in the guide catheter
- Finish with one polishing run.
  - No RPM drop
  - Little to no resistance
• As the indications for angioplasty grow with Drug-Eluting stents, so will the number of complex lesions to be treated
  – Calcified lesions
  – Long & diffuse disease
  – Small vessels
  – Bifurcations
  – Multi-vessel disease

• Number of patients sent for CABG may decrease

Do We Need Rotablator?
Rotablator has been newly re-defined as a tool for:

- modification of a plaque
- improving the plaque and vessel compliance
- better performing PCI in difficult situations
The Rotablator is mainly used to improve procedural success rate in heavily calcified lesions.
**Calcified Lesions**

*Can somebody help me?*

The prevalence of severe calcium, defined as superficial in nature with greater than $180^\circ$ arc, is estimated to present itself in **12% of cases** using angiographic imaging. When IVUS guidance is used, it’s seen in approximately **26% of cases**.

**Achieving optimal stent expansion is a crucial fact for both acute outcomes and restenosis rates**

**Heavy calcification increases the risk of incomplete stent expansion**

- Asymmetrical stent expansion occurs in up to **50% of cases** where calcium is not treated before stent deployment.
The Rotablator is mainly used to improve procedural success rate in heavily calcified lesions.

✓ The rate of failure to reach the target site within the coronary artery with the stent increases from 1.8% in non-calcified lesions up to 5.8% in heavily calcified vessels.

✓ Rotablator through plaque/lesion modification and improvement of arterial compliance allows the passage of balloons and stents, facilitates a more uniform and symmetrical stent deployment.

✓ In heavily calcified lesions procedural success rate with RA ranges from 89 to 98%
Theoretically, RA and DES could act synergistically in complex lesions

**Device Synergy**

**DES**
- Plaque compression
- Scaffolding support
- Prevents elastic recoil
- Achieves larger MLD
- Smooth lumen
- Suppress neointimal proliferation

**Rotational Atherectomy**
- Pulverizes plaque
- Effective in calcified lesions
- Changes lesion compliance
- Decreases plaque shifting

**Rota-DES**
- Full stent expansion and deployment
- Decrease subacute thrombosis
- Better MLD
- Decrease restenosis and TLR
Rotational atherectomy followed by drug-eluting stent implantation in calcified coronary lesions.


The rate of target lesion revascularisation (TLR) was 9.5%.

CONCLUSIONS: RA followed by DES implantation in severely calcified coronary lesions appears to be feasible including high rate of procedural success and low-incidence of TLR considering this complex lesion subset.

Drug-eluting stents following rotational atherectomy for heavily calcified coronary lesions: long-term clinical outcomes.

Benezet J, Díaz de la Llera LS, Cubero JM, Villa M, Fernández-Quero M, Sánchez-González A.

The combined endpoint occurred in 12.7% of cases.

CONCLUSION: DES following rotational atherectomy for heavily calcified coronary lesions is a safe and effective procedure that provides good long-term clinical outcomes.

The use of rotational atherectomy and drug-eluting stents in the treatment of heavily calcified coronary lesions.

Dardas P, Mezlis N, Ninios V, Tsikaderis D, Theofiliogiannakos EK, Lampropoulos S.

major adverse cardiac events was 14.85%.

CONCLUSIONS: The combination of RotA and DES in calcified coronary artery lesions has a very good angiographic result and a satisfactory clinical outcome.
[Safety and efficacy of rotational atherectomy followed by drug-eluting stenting for treating patients with heavily calcified coronary lesions].  
65 cases

major adverse cardiovascular events 13.8%

CONCLUSION: Rotational atherectomy followed by drug-eluting stent implantation is a safe and efficient technique for treating heavily calcified coronary lesions.


Long-term clinical outcome of rotational atherectomy followed by drug-eluting stent implantation in complex calcified coronary lesions.


the cumulative incidence of MACE (Kaplan-Meier estimate) was 17.7%.

CONCLUSION: This study represents the largest European data set of patients treated with RA in the DES era. RA followed by DES implantation in calcified coronary lesions appears to be feasible and effective, with a high rate of procedural success and low incidence of TLR and MACE at long term considering this complex patient and lesion subset.
However it should be emphasized that any reduction of restenosis might well have resulted from DES platform alone, while Rotablator may only contributed by allowing stent delivery and proper deployment.
**DES implantation after rotational atherectomy demonstrated significant reduction in TLR**

<table>
<thead>
<tr>
<th>Author/s</th>
<th>Patient Number (N)</th>
<th>Age (y)</th>
<th>In-hospital deaths/MACE (N) (%)</th>
<th>Mean FU</th>
<th>FU MACE/TLR/TVR (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Clavijo LC et al 2006</td>
<td>81</td>
<td>71.5 ± 9.6</td>
<td>0 (0%)/1 (1.3%)</td>
<td>6 mo</td>
<td>11.0/4.2/??</td>
</tr>
<tr>
<td>Furuichi S et al 2009</td>
<td>95</td>
<td>68 ± 9</td>
<td>0 (0%)/3 (3.2%)</td>
<td>17.4 mo</td>
<td>15.8/9.5/11.6</td>
</tr>
<tr>
<td>Tamekiyo H et al 2009</td>
<td>79</td>
<td>70.6 ± 10.72</td>
<td>2 (2.5%)/3 (3.8%)</td>
<td>730 d</td>
<td>30.1/25.0/??</td>
</tr>
<tr>
<td>García de Lara et al 2010</td>
<td>50</td>
<td>70 ± 1.2</td>
<td>2 (4%)/2 (4%)</td>
<td>14 mo</td>
<td>8.0/6.0/??</td>
</tr>
<tr>
<td>Rathore et al 2010</td>
<td>391</td>
<td>70.8 ± 8.8</td>
<td>4 (1%)/10 (2.5%)</td>
<td>6—9 mo</td>
<td>??/10.6/??</td>
</tr>
<tr>
<td>Mezilis N et al 2010</td>
<td>150</td>
<td>70 ± 8</td>
<td>0 (0%)/0 (0%)</td>
<td>3 y</td>
<td>11.3/2.0/2.0</td>
</tr>
<tr>
<td>Benezet J et al 2011</td>
<td>102</td>
<td>68.8 ± 7.4</td>
<td>1 (0.9%)/3 (2.9%)</td>
<td>15 mo</td>
<td>12.7/8.8/??</td>
</tr>
<tr>
<td>Chiang MH et al 2011</td>
<td>67</td>
<td>73.2 ± 10.35</td>
<td>(7.5%)/5 (7.5%)</td>
<td>23 mo</td>
<td>17.9/10.4/10.4</td>
</tr>
</tbody>
</table>
Controversy exists over whether rotablation should be performed due to the presence of severe calcifications in the coronary angiogram (primary rotablation) or only after failed conventional coronary intervention (secondary rotablation).
ROTAXUS

A Prospective, Randomized Trial of High-Speed Rotational Atherectomy Prior to Paclitaxel-Eluting Stent Implantation in Complex Calcified Coronary Lesions

.. to evaluate whether routine rotablation prior to DES implantation is more effective than the standard of care (balloon and DES) in the setting of complex calcified coronary artery disease.
240 patients enrolled between August 2006 and March 2010 at 3 clinical sites in Germany

1:1 randomization

Rota + PES (N=120)

PTCA + PES (N=120)

240 patients analyzed with complete in-hospital follow-up

- 2 patients died in-hospital
- 6 patients withdrew consent
- 5 patients lost at follow-up

Clinical follow-up at 9 months in 96.2% (N=227)

Angiographic follow-up at 9 months in 80.5% (N=190)
**Procedural outcome**

- **Angiographic success**: 96.7% (Rota+PES) vs. 96.7% (PTCA+PES) with p = 1.0
- **Stent loss**: 0% (Rota+PES) vs. 2.5% (PTCA+PES) with p = 0.08
- **Crossover**: 4.2% (Rota+PES) vs. 12.3% (PTCA+PES) with p = 0.02
- **Strategy success**: 92.5% (Rota+PES) vs. 83.3% (PTCA+PES) with p = 0.03
Primary Endpoint

In-Stent Late Lumen Loss at 9 Months

- Rota+PES: 0.44 mm
- PTCA+PES: 0.31 mm

p = 0.01
Events at Follow-Up

- **Death:**
  - Rota+PES: 5.0%
  - PTCA+PES: 5.8%
  - p = 0.78

- **MI:**
  - Rota+PES: 6.7%
  - PTCA+PES: 5.8%
  - p = 0.79

- **TVR:**
  - Rota+PES: 16.7%
  - PTCA+PES: 18.3%
  - p = 0.73

- **TLR:**
  - Rota+PES: 11.7%
  - PTCA+PES: 12.5%
  - p = 0.84

- **MACE*:**
  - Rota+PES: 24.2%
  - PTCA+PES: 28.3%
  - p = 0.46

- **Definite ST:**
  - Rota+PES: 0.8%
  - PTCA+PES: 0%
  - p = 1.0

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Although routine RA did not improve DES efficacy, RA remains an important tool for uncrossable or undilatable lesions and improves overall procedural success in this setting.

A strategy of balloon dilation with provisional rotablation before stenting should remain the default strategy for complex fibrotic/calcified lesions in the DES era.
In patients with failed conventional intervention rotablation is feasible and associated with periprocedural complications and clinical outcomes at 6 months similar to those for primary rotablation.
Guidelines on myocardial revascularization

The Task Force on Myocardial Revascularization of the European Society of Cardiology (ESC) and the European Association for Cardio-Thoracic Surgery (EACTS)

Rotablation is recommended for preparation of heavily calcified or severely fibrotic lesions that cannot be crossed by a balloon or adequately dilated before planned stenting.
The decision to use rotablation should be made early, before large dissections appear.
Rotational atherectomy is one of the few techniques that can quickly and elegantly address the difficulty of traversing these heavily calcified arteries by metal stents, no matter how tightly they are affixed to their balloon catheters or how compliant and flexible the delivery system is rendered by their manufacturers.
**Can we with DES and balloons alone?**

**Rota-Rescue** defined as Rotational Atherectomy for:

- Inability to cross the lesion with the balloon
- Inability to completely inflate the balloon
- Inability to deliver a stent
**Rota-Rescue**

*Inability to cross the lesion with the balloon*

- **Failure to cross with a balloon** is a well recognized cause of failure to recanalise a CTO or calcified/tortuous vessels despite successfully positioning a guidewire into the distal true lumen and accounts for 10%–15% of all procedure failures.

- RotA is a safe and effective technique to overcome this frustrating situation.

- Initiating treatment with the smallest burrs (1.25 mm) is the safest approach (subintimal tracking of the guide wire frequently created during CTO crossing—minimize the risk of vessel perforation).
<table>
<thead>
<tr>
<th>Author</th>
<th>Lesion</th>
<th>N</th>
<th>Success (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Reisman (1993)</td>
<td>Non dilatable</td>
<td>34</td>
<td>97</td>
</tr>
<tr>
<td>Brogan (1993)</td>
<td>Non dilatable</td>
<td>41</td>
<td>90</td>
</tr>
<tr>
<td>Sievert (1993)</td>
<td>Non dilatable</td>
<td>32</td>
<td>97</td>
</tr>
<tr>
<td>Rosenblum (1992)</td>
<td>Non dilatable</td>
<td>40</td>
<td>97</td>
</tr>
</tbody>
</table>

**Rotablator Published Reports : Non dilatable lesions**

W.C. Brogan et al. (Washington) *Am J Cardiol* 1993;71:794-798
n = 41 pts, 50 lesions in 8 immediately after balloon; in 33 on average 17 days (1-79)
Angiographic success: 98% (49/50) (1 elective CABG)
Procedural success: 90% (37/41)
MACE: 7% (3) 2 emCABG (1 death); 1 death day 14
Late clinical outcome: 7.2±3.4 months
MACE: 27% (5 re-PTCA; 2 CABG; 3 deaths)
Angio follow-up in 17 pts. (46%) – restenosis rate: 35% (6)
Rotablator: bifurcation lesions

Although not routinely applied in bifurcation lesions, rotational atherectomy of the main branch before stent implantation has been proposed to prevent plaque shifting in order to achieve side branch patency.

Use low burr-artery ratios (<0.5) especially when there is angulation present.
In ostial lesions (specifically in RCA) the frequent fibrocalcific characteristics of these lesions make them well suited for rotablation treatment.

<table>
<thead>
<tr>
<th>Author</th>
<th>lesion</th>
<th>N</th>
<th>Success (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Koller (1994)</td>
<td>Ostial</td>
<td>29</td>
<td>93</td>
</tr>
<tr>
<td>Zimarino (1994)</td>
<td>Ostial</td>
<td>69</td>
<td>92</td>
</tr>
<tr>
<td>Popma (1993)</td>
<td>Ostial</td>
<td>105</td>
<td>97</td>
</tr>
</tbody>
</table>

In ostial lesions, the success rate of the Rotablator procedure is > 90%
Have You Ever Experienced

“Stent Regret?”

Post Stent Result: single 2.75mm stent

Post Dilation: 3.5x9mm non-compliant balloon for 30 seconds @ 22atm followed by 4.0x9mm non-compliant balloon for 30 seconds @ 16atm

Post Dilation Result

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Stentablation as a Successful Treatment Strategy for Stent Underdeployment due to Calcified Plaque

Chelliah RK*, Bourantas C, Thackray SD and Alamgir MF

Hull & East Yorkshire Centre for Cardiology & Cardiothoracic Surgery, Castle Hill Hospital, Cottingham HU16 5JQ, UK

double balloon
Coronary angiography reveals a 90% stenosis of the right coronary artery (RCA) (A). Direct stenting of the bare metal stent (BMS) results in an underexpansion (B) and residual stenosis in the mid-part (C).
Rotational atherectomy of the remaining calcified stenosis within the stent and the underexpanded stent struts (stentablation) (A) with acceptable result in the following angiography. Drug eluting stent (DES) implantation (rotastenting) (B) after rotational atherectomy without any evidence for residual stenosis in final angiogram (C)
Complications specifically seen with Rotational Atherectomy

✓ Slow/no reflow
✓ Distal embolization
✓ Coronary spasm
✓ Coronary perforation
✓ Coronary dissection.

✓ **Burr entrapment** is one of rare but serious complications of the Rotablator, and previous report indicated that it occurred in 6 of 1,403 procedures (0.4%)
Two mechanisms have been proposed previously.
1. A small burr can be advanced beyond a heavily calcified plaque before sufficient ablation, especially when the burr is pushed firmly at high rotational speed. During high speed rotation, the frictional heat may enlarge the space between plaques. Meanwhile, the coefficient of friction during motion is less than that at rest, which may facilitate the burr to pass the calcified lesion easily without debulking a significant amount of calcified tissue.
   - In this situation, the ledge of calcium proximal to the burr may prevent burr withdrawal. This phenomenon was named “kokesi” after the Japanese doll by Kaneda et al.

2. The burr can be entrapped within a severely calcified long lesion, especially angulated and concomitant coronary spasm.
   - When a large burr was pushing vigorously against such lesion without sufficient pecking motion, the rotational speed may decrease significantly and this type of entrapment may occur.
Accidental entrapment in or distally to the lesion.

What to do????

1. Run away?
2. Pray hard?
3. Surgical advise?
4. Pull forcefully?
5. Use strong spasmolytics and try to pull?
6. Use a parallel wire and dilate with a ballon and then try to pull?
7. Other options?
The simplest method to retrieve the entrapped burr is pulling back the rotablator system manually.

In some cases the stuck burr can be withdrawal successfully by manual traction with on-Dynaglide or off-Dynaglide rotation.
Attempting to withdraw the burr pulls the guide catheter deeply down the LAD artery (blue dashed arrow).

- The vessel may perforate and proximal segment may be injured.
- Extreme force on the burr and burr shaft may also result in shaft fracture.

Disengaged the GC from vessel ositum and sending another GW deep into aorta may prevent vessel injury by avoid deep seating of GC during traction.
Recrossing another guide wire just beside the entrapped burr and making a crack between the burr and vessel wall by inflating a balloon catheter might be a more promising strategy.

The lesion surrounding the entrapped burr is always heavily calcified and usually need a **hydrophilic-coated wire** to pass it and sometimes **stiffer wire such as Conquest wire** may be needed to pass the adjacent hard plaque.

**Usefulness of Conquest Guidewire for Retrieval of an Entrapped Rotablator Burr**

Masayuki Hyogo,* MD, Naoto Inoue, MD, FSCAI, Reo Nakamura, MD, Takaomi Tokura, MD, Akiko Matsuo, MD, Keiji Inoue, MD, Tetsuya Tanaka, MD, PhD, and Hiroshi Fujita, MD, PhD

We experienced an entrapped rotablator burr that could not be retrieved even by deep seating of the guiding catheter. We successfully retrieved the burr by balloon inflation after the tapered tip of a Conquest wire managed to penetrate the quite hard plaque and pass through the outer lumen of the burr. *Catheter Cardiovasc Interv* 2004;63:469–472.
Another approach, which requires a 7 Fr guide catheter, is to cut the proximal end of the atherectomy catheter shaft and RotaWire and advance a snare over the shaft down close to the lesion (Simultaneous traction on the snare and guiding catheter)

✓ This method, inspired by pacemaker lead extraction techniques

✓ The use of a percutaneous snare in conjunction with partial disassembly of the rotablator apparatus allows the application of traction locally to the site of the entrapped burr in a more controlled fashion. This reduces the risk of traumatizing either the left main stem or other parts of the vasculature.
Alternatively, after the shaft has been cut, a child catheter (Heartrail® ST01; Terumo, Tokyo, Japan or GuideLiner®; Vascular Solutions, Minneapolis, MN, USA) can be advanced up to the burr: simultaneous traction on the burr shaft and counter-traction on the child catheter can result in successful retrieval of the trapped burr.
GuideLiner, A Child-In-A-Mother Catheter for Successful Retrieval of an Entrapped Rotablator Burr


Michael Cunnington, BMEDSCI, MBBS MRCP, MD, and
Mohaned Egred,* BSC(HONS), MB, CHB, FRCP, MD

can be attempted. We describe a novel technique to remove a trapped rotablator burr from a heavily calcified lesion using counter-traction with a GuideLiner, a child-in-a-mother catheter, which successfully removed the entrapped burr without the need for surgery when simple traction alone had been ineffective.

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There are a number of manoeuvres which can be tried, but if all are unsuccessful, then the patient will require emergency surgery.

**Trapped Rotablator: Kokesi Phenomenon**

Hideaki Kaneda,* MD, Shigeru Saito, MD, George Hosokawa, MD, Shinji Tanaka, MD, and Yoshitaka Hiroe, MD

We experienced a rare complication of rotational atherectomy. The burr was trapped at the angled, calcified narrowing in the left anterior descending coronary artery. The burr was retrieved after the resection of the pulmonary artery and the left coronary artery. We will discuss the cause and prevention of this complication. *Cathet. Cardiovasc. Intervent.* 49:82–84, 2000. 2000 Wiley-Liss, Inc.

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How to prevent burr entrapment?

✓ Gentle pecking motion and short runs of rotablation (< 15 s)

✓ Operators should start RA in eccentric and extremely calcified lesions with relatively small burrs and a higher speed of rotation.

✓ When a smaller burr was employed, more slowly advancement to ablate the plaque of proximal lesion sufficiently was recommended, and too high a burr speed should also be avoided to prevent “kokesi phenomenon.”

✓ Operators should not exert excessive forward force during burr advancement and should avoid significant decelerations of rotational speed (>5000 rpm) in order to avoid entrapment.
ROTATIONAL V.S ORBITAL ATERECTOMY

Rotablator™ Rotational Atherectomy System's diamond-tipped burr spins concentrically on the wire.

Goal is to create a smooth concentric lumen.

Orbital atherectomy is designed to oscillate in an orbital path.

Increased speed = Larger orbital diameter.

ORBIT II Trial: 11.7% coronary vessel dissection rate on subjects treated with OAS¹

Bench testing intended to show differentiated mechanisms of action. Bench test results may not be indicative of clinical performance.
## Rotational v.s Orbital Atherectomy

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<tr>
<th>Profile</th>
<th>Rotablator®</th>
<th>Diamondback 360*</th>
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<td><img src="image1.png" alt="Rotablator® Image" /></td>
<td><img src="image2.png" alt="Diamondback 360* Image" /></td>
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<th>Cutting Mechanism</th>
<th>Rotablator®</th>
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<td>Front cutting</td>
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<th>Grit Size</th>
<th>Rotablator®</th>
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<td><img src="image3.png" alt="Grit Size Rotablator®" /></td>
<td>5 μ exposed diamonds</td>
<td>10 μ exposed diamonds*</td>
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[www.e-Cardio.gr](http://www.e-Cardio.gr)
**ORBIT II Procedural Complications**

- NQWMI (CK-MB > 3 ULN): 8.8%
- Dissection: 11.7%
- Perforation: 1.8%
- Death: 0.2%
- Slow/No Flow: 0.9%

**ROTAXUS Procedural Complications**

- NQWMI (CK-MB > 3 ULN): 1.7%
- Dissection: 3.3%
- Perforation: 1.7%
- Death: 1.7%
- Slow/No Flow: 0%

**ROTAXUS**

Rotational Atherectomy showed low rate of complications in a real-world patient population.

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# NEXT GENERATION

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Asahi RotaWire Elite®

Next Gen Rotablator®
Next Gen Advancer®
Next Gen Console®
Choice, not circumstances, determines your success.
Design Goals of NG Rotablator:
1. Easier to use (no foot pedal)
2. Easier to set-up (consolidated cables)
3. Still air driven
   - Same drive shaft
   - Same burr
Design Goals:
- Easier to learn & use (no foot pedal)
- Easier to set up (consolidated cables)
- Allows single operator use

*The next generation Rotablator devices are under development not available for sale.*
- Mounted IV pole
- Less set up time
- Modern display
  - On screen deceleration alert
  - Vertical or horizontal display
Asahi RotaWire Elite*

Design Goals: 1:1 Torqueability

Stainless steel core wire technology

Same wire dimensions and tip design
Will be available in Floppy & Extra Support versions