

# A New Era for Rotational Atherectomy: An Australian Perspective

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Clinical Medicine Insights: Cardiology

Volume 13: 1–6

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DOI: 10.1177/1179546819852070



## ABSTRACT

**BACKGROUND:** Rotational atherectomy (RA) has been used in percutaneous coronary intervention (PCI) for 30 years. With advances in technology, this observational study looks at how rates of RA have changed over the past decade in Australia in relation to PCI and coronary artery bypass graft (CABG) rates.

**METHODS:** Retrospective analysis of RA, PCI, and CABG rates per Australian state from Australian Government Department of Human Services' data on Medicare items from 2007 to 2017 was carried out.

**RESULTS:** There were 149 RA procedures in 2007, increasing to 452 in 2017. Rotational atherectomy accounted for 0.67% of PCI procedures in 2007, increasing to 1.48% in 2018 (+0.81%, 95% confidence interval [CI] = [0.64%-0.91%];  $P < .001$ ). Most of this increase has come from procedures in New South Wales (441% increase). Australian PCI rate increased from 22301 to 30480. Rate of CABG decreased from 5418 to 5206.

**CONCLUSIONS:** From 2007 to 2017, rates of RA trebled in Australia. This is despite stable rates of PCI and a fall in rates of CABG. There are several clinical explanations for this trend.

**KEYWORDS:** Australian data, rotational atherectomy, coronary artery bypass graft, percutaneous coronary intervention, interventional cardiology

**RECEIVED:** October 26, 2018. **ACCEPTED:** April 29, 2019.

**TYPE:** Original Research

**FUNDING:** The author(s) received no financial support for the research, authorship, and/or publication of this article.

**DECLARATION OF CONFLICTING INTERESTS:** The author(s) declared the following potential conflicts of interest with respect to the research, authorship, and/or publication of this article: BG reports receiving proctorship fees for the WATCHMAN™ device (Boston Scientific Corporation). No other potential conflict of interest relevant to this article was reported.

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## Introduction

Rotational atherectomy (RA) has been practised by cardiologists for over 30 years.<sup>1</sup> The technique involves debulking atherosclerotic plaques in coronary arteries via an abrasive intraluminal burr. In the late 20th century, RA was employed regularly in percutaneous coronary intervention (PCI);<sup>2</sup> however, in the drug-eluting stent era, it fell out of favour.<sup>3</sup> Multiple trials had shown that routine use of RA had no benefit in angiographic outcome during routine PCI.<sup>4,5</sup> Furthermore, it risked several complications, including but not limited to severe vessel spasm, coronary artery dissection, perforation, and no-reflow.<sup>6–10</sup>

Since these early trials, RA's use has evolved: providing a necessary adjunct to modify both heavily calcified lesions and ostial side branch lesions prior to balloon expansion and stent deployment,<sup>11</sup> as well as offering a feasible alternative to surgery in high-risk patients.<sup>12</sup>

Although still not indicated routinely, it is useful in tackling complex lesions when standard balloon dilatation fails, with the Australian Medicare Benefits Schedule (MBS) advising that RA be available for revascularisation of complex and heavily calcified coronary artery stenoses in patients for whom coronary artery bypass graft (CABG) surgery is contraindicated.<sup>13</sup>

Rotational atherectomy involves an elliptically shaped burr with a distal tip coated in diamond chips that range in size from 20 to 30  $\mu\text{m}$  diameter. This is rotated via an air motor at 140 000 to 200 000 r/min, resulting in differentially cut inelastic material.

While national registry data have been published in recent years from other parts of the world, including Japan (accounting for 3.2% of PCI procedures) and Europe (ranging from 0.8% to 3.1%), no such study has looked at the Australian cohort.<sup>8,14</sup> Our aims were to calculate rates of RA in Australia over the past decade and to compare these with rates of PCI and CABG surgery.

## Method

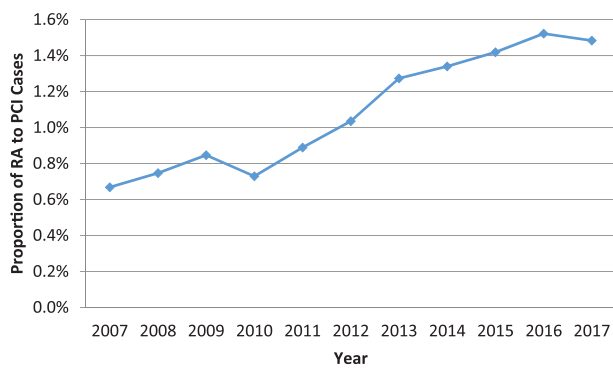
Australia's MBS lists all outpatient and private hospital coronary catheterisation procedures. Rotational atherectomy has been available on the MBS since 2003. We analysed Australian Government Department of Human Services data on MBS items for coronary artery RA (code numbers 38309, 38312, 38315, 38318), PCI (code numbers 38300, 38303, 38306) and CABG (code numbers 38497, 38498, 38500, 38501, 38503, 38504) from January 2007 to December 2017 ([http://medicarestatistics.humanservices.gov.au/statistics/mbs\\_item.jsp](http://medicarestatistics.humanservices.gov.au/statistics/mbs_item.jsp),



**Table 1.** Changes in rates of RA, PCI, and CABG procedures in Australia from 2007 to 2017.

YEAR	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
RA	149	164	200	171	219	258	330	362	393	441	452
PCI	22301	21960	23625	23444	24639	24910	25913	27021	27704	28977	30480
CABG	5418	5275	5004	4837	4728	4841	5119	5109	5339	5197	5206

Abbreviations: CABG, coronary artery bypass graft; PCI, percutaneous coronary intervention; RA, rotational atherectomy.



**Figure 1.** RA rates as a proportion of PCI procedures performed from 2007 to 2017. PCI, percutaneous coronary intervention; RA, rotational atherectomy.

full description of code numbers is available in Appendix 1). The study protocol was submitted to the following independent Ethics Committee: Central Coast's Local Health District Research Governance Office. As no individual patient data were collected with the information freely available, the study received exemption from ethics approval.

### Statistical analysis

The number of RA, PCI, and CABG procedures were counted for each year from each state in Australia. Microsoft Excel (Microsoft Corp, Redmond, WA, USA) and Stata Version 15 (StataCorp LP, College Station, TX, USA) were used to analyse data. Frequency polygons were used to present and compare graphically RA and PCI rates between 2007 and 2017. The Royston chi-square test for trend was used to test the null hypothesis of change in RA rates over time with 5% level of significance ( $P < .05$ ).<sup>15</sup>

### Results

Rates of RA have trebled in Australia over the past 10 years from 149 procedures in 2007 to 452 in 2017 (Table 1). During the same period, PCI rates increased modestly from 22301 to 30480 procedures per year, and CABG rates fell during this period from 5418 procedures in 2007 to 5206 procedures in 2017, representing a 5.3% decline (Table 1).

In 2017, RA was used in 1.48% of PCI procedures, significantly up from 0.67% of procedures in 2007 (+0.81%, 95% confidence interval [CI] = [0.64%-0.91%]);  $P < .001$  (Figure 1). There is significant geographic variation between Australian states in RA uptake (Figure 2). Most of this increase has come from procedures in New South Wales (441% increase) and Queensland (219% increase). Despite being the second most

populous state (6.3 million) with the fastest rate of population growth,<sup>16</sup> Victoria's RA rates have plateaued.

In relation to PCI procedures, there has been a significant proportional increase in trend of RA procedures seen in New South Wales, Queensland, South Australia, Western Australia, and Tasmania (Table 2, appendix 2).

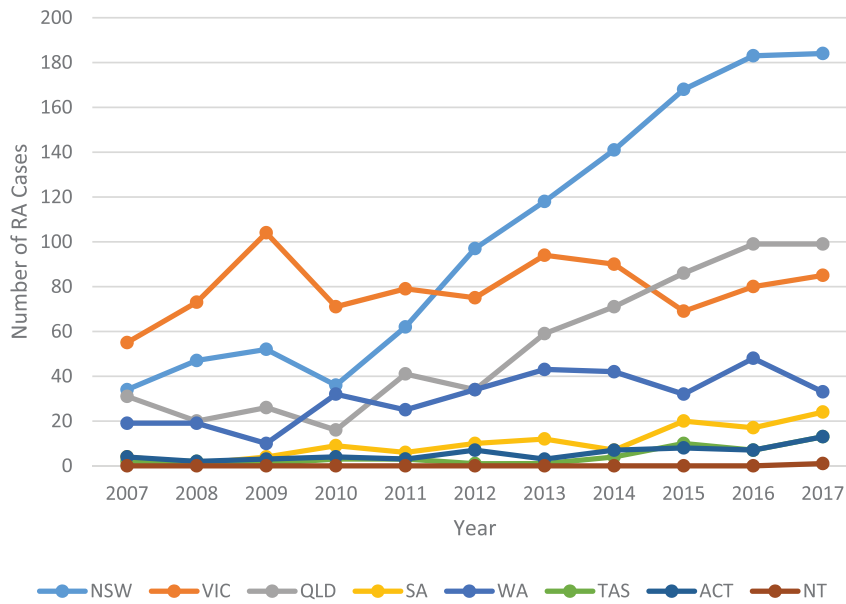
In 2007, of the 149 RA procedures performed, 85% (127 procedures) underwent PCI with RA, with the remaining 15% (22 procedures) solely undergoing RA as stand-alone procedures. By 2017, the proportion undergoing PCI with RA had increased to 95% with the remaining 5% occurring as stand-alone procedures (Figure 3).

### Discussion

Rotational atherectomy was commonly used as both a stand-alone procedure and later as a prelude to balloon dilation for modifying coronary artery plaques.<sup>17</sup> Up to 20% of interventional procedures involved the technique 30 years ago, but its use declined to around 1% with the evolution of easy-to-deploy drug-eluting stents, the lack of benefit in preventing re-stenosis, and the risk of serious ischaemic complication such as cardiogenic shock.<sup>18-20</sup> Despite this, national registry data had shown that its use remained stable in the early 21st century,<sup>3</sup> as clinicians recognised that RA provided a necessary aide to PCI, with current American Heart Association's (2011) guidelines stating that 'rotational atherectomy is reasonable for fibrotic or heavily calcified lesions that might not be crossed by a balloon catheter or adequately dilated before stent implantation'.<sup>21</sup>

Our findings show that rates of RA have increased significantly over the past decade in Australia against the trends seen in PCI or CABG rates. These results show that Australia sits in line with European countries such as the United Kingdom, Holland, and Portugal (comprising 1.3%, 1.4%, and 1.5%, respectively) for the rate of atherectomy procedures performed as a proportion of PCI.<sup>14,22</sup> While an observational study suggested that rates of RA have increased in the United Kingdom over the past decade, little data are available on worldwide trends.<sup>23</sup> Given the risks of treating elderly cardiovascular patients with surgical intervention,<sup>24</sup> the proportional rise seen in RA might reflect a demographic shift: with an increased willingness to treat elderly, high-risk, patients with complex lesions via angiographic (vs surgical) means. Indeed, in the US cohort, CABG surgery rates had decreased by 5% annually from 2001 to 2009.<sup>14,25</sup>

It is unclear why such regional trends exist, with Australian demographic statistics showing little change over this time,



**Figure 2.** RA rates by Australian state from 2007 to 2017.

Source: Australian Government Department of Human Services data on Medicare items.

ACT indicates Australian Capital Territory; NSW, New South Wales; NT, Northern Territory; QLD, Queensland; RA, rotational atherectomy; SA, South Australia; TAS, Tasmania; VIC, Victoria; WA, Western Australia.

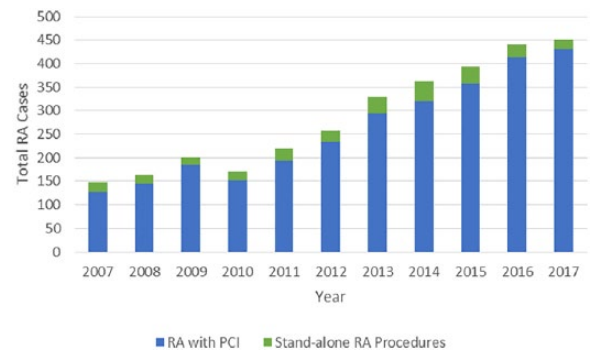
**Table 2.** Proportion of rotational atherectomy cases to percutaneous coronary interventional cases per state.

STATE	CHI-SQUARE STATISTIC (DF = 1)	P VALUE
NSW	186.723	<.001
VIC	0.220	.639
QLD	81.228	<.001
SA	35.863	<.001
WA	8.513	.004
TAS	11.504	.001
ACT	3.758	.053
NT	2.016	.156

Abbreviations: ACT indicates Australian Capital Territory, *df*, degrees of freedom; NSW, New South Wales; NT, Northern Territory; QLD, Queensland; SA, South Australia; TAS, Tasmania; VIC, Victoria; WA, Western Australia.

with the population of New South Wales and Australia increasing from 6.8 and 20.9 million in 2007 to 7.8 and 24.6 million in 2017, respectively.<sup>26</sup>

There are several clinical explanations for the upward trend seen in RA. First, with the use of intravascular ultrasound, there has been greater appreciation of heavily calcified plaques that are otherwise unsuitable for PCI. Mintz et al<sup>27</sup> found that coronary calcification was poorly appreciated at angiography, being seen in 38% of lesions, with this figure increasing to 73% if intravascular ultrasound was used. While no study has looked at intravascular ultrasound usage in Australia, as its use has increased, use of RA might also have increased. Second, complication rates have decreased with a Cochrane systematic review (2012) reporting that the incidence of post-procedure major adverse cardiac events



**Figure 3.** RA use as part of PCI versus as a stand-alone procedure in Australia from 2007 to 2017. PCI indicates percutaneous coronary intervention; RA: rotational atherectomy.

as being similar between RA and angioplasty (relative risk (RR) = 1.27; 95% CI = [0.86-1.90]).<sup>28</sup> The reasons behind the improvements seen in complication rates are 3-fold, including (1) smaller catheters, (2) a radial artery approach (with a bleeding complication rate of 0.04% radially vs 1.3% femorally), and (3) modern perfusionists avoiding large burr sizes and excessive deceleration speeds (both of which can lead to increased complication rates).<sup>22,29-31</sup> Third, recent studies have shown that RA use prior to drug-eluting stent deployment can reduce the risk of stent deployment failure.<sup>32,33</sup> With the advent of new technologies, including orbital atherectomy (which is not currently available in Australia),<sup>19</sup> there is likely to be further interest in tackling complex lesions with atherectomy.

The main limitation of this observational study is that it is reliant on the MBS dataset (as discussed further in Appendix 1). It does not include patients who do not qualify for MBS, and this suggests the presence of selection bias. Furthermore, this dataset does not provide baseline characteristics of the population such as age, gender, or coronary artery calcium

score, nor changes in complication rates. It is unclear from this study whether RA results in improved patient outcome.

## Conclusions

Rates of RA have increased dramatically over the past decade in Australia and specifically New South Wales during a time when PCI rates have plateaued and CABG rates fallen. With increasing awareness of heavily calcified lesions, an ageing population, and improvements in technology, we predict RA use to increase further in the coming years.

## Author Contributions

PB devised the project and was a major contributor to writing the manuscript. MP was a major contributor to writing the manuscript. BG was a major contributor to writing the manuscript. MP analysed the data and contributed to the statistical analysis and results sections. GL oversaw the project's development.

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## Appendix 1

Australia's Medicare Programme allows all 'clinically relevant' services (defined as being deemed necessary for the appropriate treatment of the patient) to be at least partially claimable as part of the MBS. While there is free treatment for public patients in public hospitals, all other services such as outpatient procedures and inpatient procedures are claimed. The list of the relevant codes for the claims listed in this study is shown below:

38300: Transluminal balloon angioplasty of 1 coronary artery, percutaneous or by open exposure, excluding associated radiological services or preparation, and excluding aftercare.

38303: Transluminal balloon angioplasty of more than 1 coronary artery, percutaneous or by open exposure, excluding



associated radiological services or preparation, and excluding aftercare.

38306 Transluminal insertion of stent or stents into 1 occlusional site, including associated balloon dilatation of coronary artery, percutaneous or by open exposure, excluding associated radiological services, radiological preparation, and aftercare.

38309: Percutaneous transluminal rotational atherectomy of 1 coronary artery, including balloon angioplasty with no stent insertion, where no lesion of the coronary artery has been stented, and each lesion of the coronary artery is complex and heavily calcified; and balloon angioplasty with or without stenting is not suitable, excluding associated radiological services or preparation, and excluding aftercare.

38312: Percutaneous transluminal rotational atherectomy of 1 coronary artery, including balloon angioplasty with insertion of 1 or more stents, where no lesion of the coronary artery has been stented, and each lesion of the coronary artery is complex and heavily calcified, and balloon angioplasty with or without stenting is not suitable, excluding associated radiological services or preparation, and excluding aftercare.

38315: Percutaneous transluminal rotational atherectomy of more than 1 coronary artery, including balloon angioplasty with no stent insertion, where no lesion of the coronary artery has been stented, and each lesion of the coronary artery is complex and heavily calcified, and balloon angioplasty with or without stenting is not suitable, excluding associated radiological services or preparation, and excluding aftercare.

38318: Percutaneous transluminal rotational atherectomy of more than 1 coronary artery, including balloon angioplasty, with insertion of 1 or more stents, where no lesion of the coronary artery has been stented, and each lesion of the coronary artery is complex and heavily calcified, and balloon angioplasty with or without stenting is not suitable, excluding associated radiological services or preparation, and excluding aftercare.

38497: Coronary artery bypass with cardiopulmonary bypass, using saphenous vein graft or grafts only, including harvesting of vein graft material where performed, not being a service associated with a service to which item 38498, 38500, 38501, 38503, or 38504 applies.

38498: Coronary artery bypass with the aid of tissue stabilisers, performed without cardiopulmonary bypass, using saphenous vein graft or grafts only, including harvesting of vein graft material where performed, either via a median sternotomy or other minimally invasive technique and where a standby perfusionist is present, not being a service associated with a service to which item 38497, 38500, 38501, 38503, 38504, or 38600 applies.

38500: Coronary artery bypass with cardiopulmonary bypass, using single arterial graft, with or without vein graft or grafts, including harvesting of internal mammary artery or vein graft material where performed, not being a service associated with a service to which item 38497, 38498, 38501, 38503, or 38504 applies.

38501: Coronary artery bypass with cardiopulmonary bypass, using single arterial graft, with or without vein graft or grafts, including harvesting of internal mammary artery or vein graft material where performed, not being a service associated with a service to which item 38497, 38498, 38501, 38503, or 38504 applies.

38503: Coronary artery bypass with cardiopulmonary bypass, using 2 or more arterial grafts, with or without vein graft or grafts, including harvesting of internal mammary artery or vein graft material where performed, not being a service associated with a service to which item 38497, 38498, 38500, 38501, or 38504 applies.

38504: Coronary artery bypass with the aid of tissue stabilisers, performed without cardiopulmonary bypass, using 2 or more arterial grafts, with or without vein graft or grafts, including harvesting of internal mammary artery or vein graft material where performed, either via a median sternotomy or other minimally invasive technique and where a standby perfusionist is present, not being a service associated with a service to which item 38497, 38498, 38500, 38501, 38503, or 38600 applies.

Appendix 2

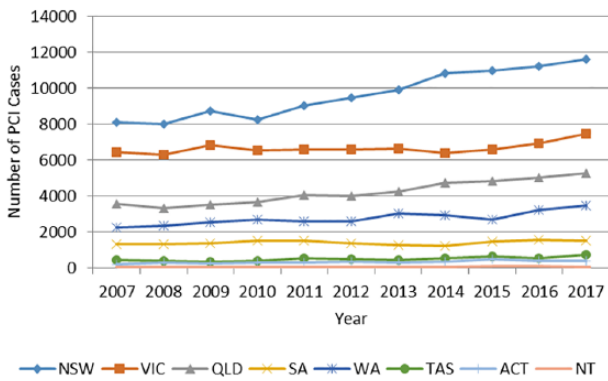


Figure 4. PCI rates by state from 2007 to 2017.

Source: Australian Government Department of Human Services data on Medicare items ([http://medicarestatistics.humanservices.gov.au/statistics/mbs\\_item.jsp](http://medicarestatistics.humanservices.gov.au/statistics/mbs_item.jsp)).

ACT indicates Australian Capital Territory; NSW, New South Wales; NT, Northern Territory; PCI, percutaneous coronary intervention; QLD, Queensland; SA, South Australia; TAS, Tasmania; VIC, Victoria; WA, Western Australia.

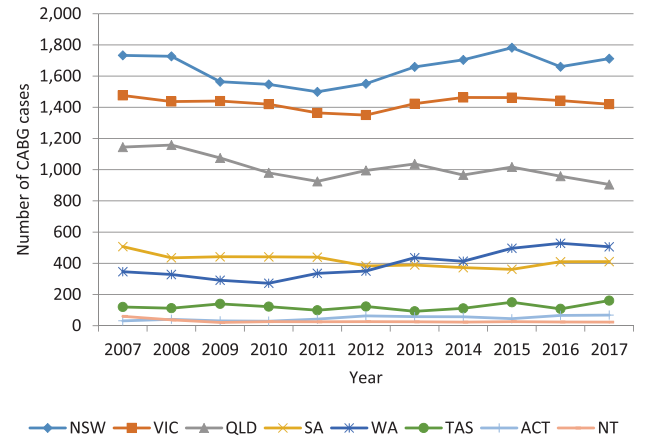


Figure 5. CABG rates by state from 2007 to 2017.

Source: Australian Government Department of Human Services data on Medicare items ([http://medicarestatistics.humanservices.gov.au/statistics/mbs\\_item.jsp](http://medicarestatistics.humanservices.gov.au/statistics/mbs_item.jsp)).

ACT indicates Australian Capital Territory; CABG, coronary artery bypass graft; NSW, New South Wales; NT, Northern Territory; QLD, Queensland; SA, South Australia; TAS, Tasmania; VIC, Victoria; WA, Western Australia.