Trends in Coronary Revascularization: A Single Center Experience from 1999- 2011

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Abstract

There are three predominate coronary revascularization modalities available in the United States of America including: coronary artery bypass grafting (CABG), percutaneous coronary intervention (PCI), and percutaneous transluminal coronary angioplasty (PTCA). The advent of Drug-Eluting Stents, as a type of PCI has revolutionized coronary revascularization. Despite the benefits of stents over CABG for multi-vessel coronary artery disease, CABG has proven to be superior. Current guidelines recommend CABG for multi-vessel coronary artery disease and left main diseases. In this paper, we are illustrating the trends of coronary revascularization from 1999 to 2011 at our institute (Providence Hospital and Medical Center). It highlights major change in trends of particular modalities with possible explanations.

KEYWORDS: Coronary Revascularization, Coronary Artery Bypass Graft, Drug-Eluting Stents, Coronary Artery Disease

Acknowledgement:
None

Introduction:

There are three predominate coronary revascularization modalities available in the United States of America (USA) including: coronary artery bypass grafting (CABG), percutaneous coronary intervention (PCI) and percutaneous transluminal coronary angioplasty (PTCA),. Coronary revascularization is widely performed and thus consumes a large share of healthcare expenditure.[1] It is the treatment of choice for patients suffering acute coronary syndrome and has been shown to reduce symptom burden in patients with chronic angina due to subtotal coronary occlusion.

Many large randomized trials have shown the key role PCI plays in management of patients of coronary artery disease. Stephen Hales reported the first cardiac catheterization in 1711 when he performed equine biventricular catheterization [1] . The era of human coronary intervention started in 1977 when a German cardiologist, Dr. Gruntzig showed a simple balloon based tool for dilating focal stenosis of coronary arteries.[2] Further advancement in the field of percutaneous intervention PCI includes the introduction of first Bare-Metal (BMS) and then Drug-Eluding Stent (DES). This advancement brought tremendous impact on the number of coronary revascularization. Epstein et al pointed out that there is an overall increase in PCI in the USA, but

the numbers of angioplasty has substantially decreased from 2001 to 2008. [1] While BMS composed a large portion of PCI in years 2001-2002, the use has also substantially decreased after the approval of DES in 2003.[1]

It is important to note that there was an increase in number of hospital performing CABG surgeries thus decreasing the patient burden per hospital for the procedure.[1] According to SYNTAX trial, CABG surgery is still as the treatment of choice for certain condition such as triple-vessel and left main coronary artery disease.

Methods:

Providence Hospital and Medical Center is a non-university community based hospital with accredited cardiology and intervention cardiology fellowships. A retrospective analysis was then performed from 1999 to 2011 using our hospital database to obtain data on the number of CABG, PCI and types of stents (if used), and PTCA/PCI (patients might have undergone PCI along with PTCA). This data was analyzed to see the trends. This study protocol was approved by our local Institutional Review Board.

Results:

Since 1999, 28510 PCI's and 3277 CABG's were performed. The total number of stents placed was 15496, of which 9075 were DES (58.6%). During the 13-year study period, 13014 (or 45.4% of all PCIs, PTCA/PCI procedures were done (Table 1). Trends of each coronary revascularization procedures are detailed below. We included total numbers of left heart catheterizations and percentages of revascularization procedures to left heart catheterizations. (Table 2)

Coronary Artery Bypass Graft

The number of CABGs since 1999 to 2011 had been declining, where the highest numbers of CABG's were performed in 1999 (438 CABG's) (Graph 1). CABGs represented about 20.9% in 1999 while about 5.6% of total revascularizations in 2011 (Table 1). The percentages of Post-PTCA CABG had been inconsistent throughout the study period; however, there had been a marked increase from 2002 to 2011.

Drug-Eluting Stents

The number of stents placement increased yearly from 1999 to 2011, though the numbers of stents used after 2005 have been decreasing (Graph 1). But when a ratio of total number of stents to total number of revascularization is compared for each year, there is an overall increase in trend from 1999 to 2011 with a slight decrease in percentages of total stents from 2006 to 2011. Since its approval from FDA in April 2003, the DES use had been inclining both at our hospital. In 2003, about 12.7% of revascularization procedures were represented by DES. By 2011, nearly 78.4% of all stents were DES or 40.8% of all revascularization procedures. Conversely, the use of BMS was at steady decline since 1999 and represented only 21.6% of all stents or about 11.3% of revascularization procedures. (Table 1)

Percutaneous Transluminal Coronary Angioplasty

In 1999, PTCA/PCI was the most performed revascularization procedure at our hospital (41.2%). Unlike CABG and stents placements, the trend for PTCA/PCI remains unchanged. When the data is compared from 1999 to 2011, there is marginal increase in the percentages of PTCA/PCI performed (41.2% vs. 42.4%). (Table 1)

Discussion:

The advent of DES, as a type of PCI has brought noticeable and significant change in the field of revascularization. In comparison with USA data, we also noted a marked decline in CABG procedures from 1999.[1] At our institute, there was a nearly four-fold decrease in the number of CABGs performed. This was also observed in a study by Gogo et al who reported in their study that about 40% percent of patients with triple-vessel diseases underwent CABG in late 2005 compared to 50% in 2002.[3] The SYNTAX trial found that the patients treated with CABG had fewer cardiac or cerebrovascular events than the patients treated with DES at 1 year follow-up.[4] While the exact reason for decrease in the numbers of CABG is unknown, an increase in the numbers of stents was observed during the same interval. CABG is an invasive, costly and high risk procedure that is not suitable for all patients requiring revascularizations. It is practical to substitute PCI for CABG for single vessel disease or in high-risk patients who are not candidates for CABG, while CABG is reserved for multi-vessel or left-main artery diseases.[5]

In our study, we observed inconsistent, but marked increase in Post-PTCA/PCI CABG. We postulate that it can be from utilization of PTCA/PCI as a bridge therapy in patients who would undergo CABG at a later time. In the FREEDOM Trial, diabetic patients with multi-vessel disease benefited from CABG than PCI for MI and overall mortality.[6]

After it was approved by FDA in April 2003, there was a sharp increase in DES use. Its rise impacted the use of BMS, as type of PCI both nationally and at our institution, while PTCA use remained unchanged at our institute. A study published in 2007 shows that there is no difference in death or myocardial infarction between DES and BMS. The first generation of DES was associated with reduced re-stenosis; however, there is increased risk of late re-stenosis.[7]

As illustrated in (Figure 1), the number of stent placement has been declining. Aggressive medical management, risk factor modifications, improved diagnostic technology and proper selection of patients are possible reasons for this observation. Noninvasive imaging modalities including fraction flow reserved and intravascular ultrasound guided coronary artery interventions could have substantial impact on the management of patients undergoing percutaneous interventions.[8]

The long term benefit of coronary revascularization was assessed by Schaefer et al that showed there was no benefit seen in DES compared with BMS after 3 years follow up. But when both types of stents are compared for cost-effectiveness, the DES is more cost-effective in the long term; patients with DES required less repeat revascularization procedures at 3-year follow up.[9] However, there was a significant increase in thrombosis-related complication associated with large caliber DES.[10]

Conclusion:

There is increasing rate of PCI along with increased use of stents but recently the number of PCI being performed has been decreasing. This may be due to advancements in noninvasive medical care. The increase in the use of BMS can be linked with issues with adherence to anti-platelet therapy, early stent

thrombosis and price. More single vessel PCI's is now being performed. However, introduction of PCI has led to a fall in the rates of CABG.

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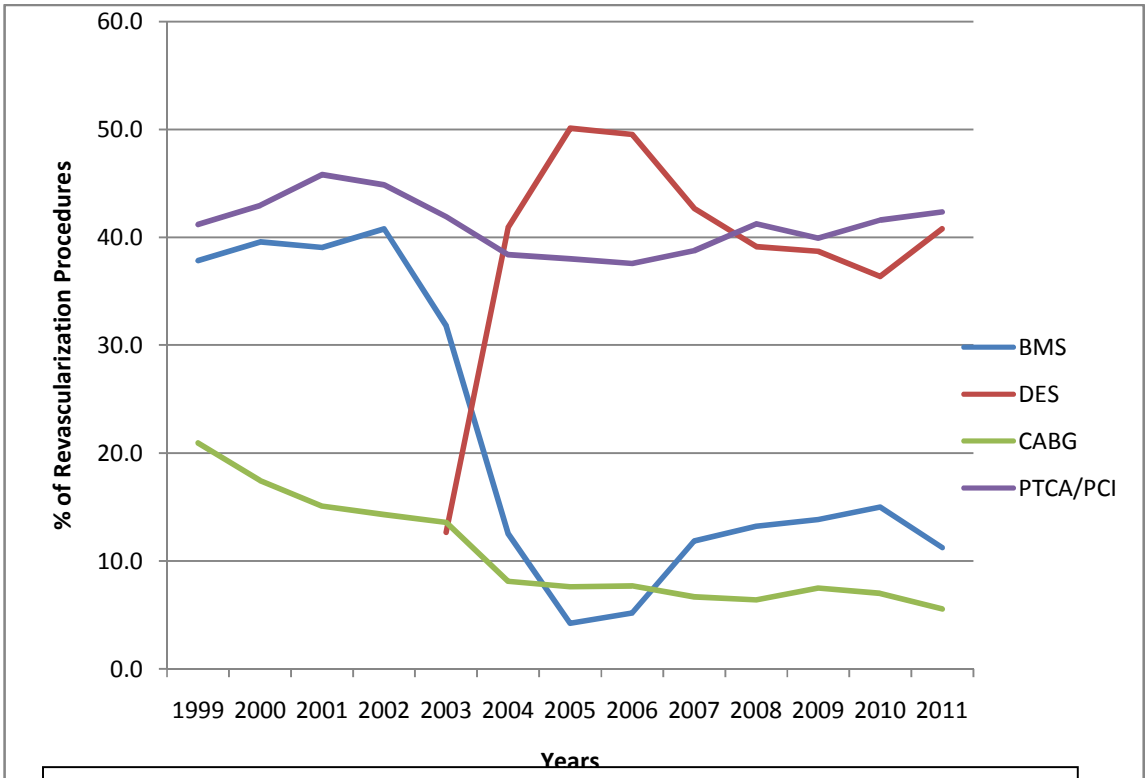

Figure 1: Percentages of coronary revascularizations from 1999-2011

Abbreviations: PCI= Percutaneous Coronary Intervention; DES= Drug-Eluting Stent; CABG= Coronary Artery Bypass Graft; PTCA/PCI = Percutaneous Transluminal Coronary Intervention/Percutaneous Coronary Intervention

Table 1: Numbers of Coronary Revascularizations

Year	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
PTCA/PCI	862	1008	996	989	973	1088	1088	1032	939	1053	1043	991	952
CABG	438	409	328	315	315	230	218	211	162	163	196	167	125
DES	N/A	N/A	N/A	N/A	294	1160	1434	1360	1034	999	1011	866	917
BMS	792	929	849	899	738	355	121	142	287	337	362	357	253

Abbreviations: PTCA/PCI = Percutaneous Transluminal Coronary Angioplasty/Percutaneous Coronary Intervention, CABG= Coronary Artery Bypass Graft, DES = Drug-Eluting Stents, BMS = Bare Metal Stents

Table 2: Coronary Revascularization Procedures and Left Heart Catheterization

Year	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
LHC	2336	2340	2396	2606	2709	2641	2735	2502	1955	2162	3155	2891	2571
Percentages of Coronary Revascularization Procedures to Left Heart Catheterization (in %)													
PTCA/PCI	36.9	43.1	41.6	38.0	35.9	41.2	39.8	41.2	48.0	48.7	33.1	34.3	37.0
CABG	18.8	17.5	13.7	12.1	11.6	8.7	8.0	8.4	8.3	7.5	6.2	5.8	4.9

Abbreviations: LHC=Left Heart Catheterizations, PTCA/PCI =Percutaneous Transluminal Coronary Angioplasty, PCI = Percutaneous Coronary Intervention, CABG= Coronary Artery Bypass Graft