Comparison between PTCA and Rotational Atherectomy

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Abstract

The purpose of this study is to show the comparison of the two coronary procedures PTCA and rotational atherectomy

A procedure that uses a balloon and stent to open up blocked arteries and one which uses a drill at 160,000 to 180,000 rpm to open heavily calcified arteries which weren't able to be opened by balloon and stent

PCI or PTCA has been a procedure that has been used since the 1970s and later on in the 1980s ROTA was introduced, even after the advancement of the PTCA using the DEB and cutting balloons yet it wasn't enough to tackle some of the calcified lesions

Rotation atherectomy is used to debulk calcified or complex coronary stenosis

ROTA works in differential cutting and preferentially ablates hard inelastic calcified plaques which have been stuck by using small burr and perking motion

Percutaneous transluminal coronary angioplasty is a minimally invasive procedure that opens blocked coronary arteries to improve blood flow to the heart muscle

Although both function in treating acute coronary diseases one seems to be riskier than the other one. This article reviews the principles, clinical indications, technical considerations, and complications associated with the use of both procedures

Introduction

Percutaneous coronary intervention (PCI) is known as percutaneous transluminal coronary angioplasty (PTCA). Percutaneous coronary intervention (PCI) is the most commonly used revascularisation modality for obstructive coronary artery disease (Cavusoglu et al., 2004)21. It is the most common procedure that is being done to save patients with coronary artery stenosis. PTCA is a non-surgical procedure or a minimally invasive procedure that requires the insertion of a catheter using either the femoral or radial artery to the heart to correct or revascularize a blocked coronary artery

PTCA is mostly done with patients with at least 70% blockage of their coronary arteries and if it is uncertain of the percentage of the blockage an FFR procedure will be done to determine if the blockage is for medication or PTCA

Fractional flow reserve (FFR) inversely evaluates the ischemic potential of coronary stenosis (Di Gioia et al., 2020).FFR has enabled interventional cardiologists to accurately determine vessels and lesions leading to ischemia (Mangiacapra et al., 2018). it is a procedure that involves measuring the maximum blood flow achieved in a diseased coronary artery and the theoretical maximum flow in a normal coronary artery and finding its ratio. If the FFR ratio is 1.0 it means it is normal and there is no requirement for PTCA, if the ratio is lower than 0.75 to 0.80 it is generally considered to be associated with MI. FFR is a validated index for determining the hemodynamic impact of coronary stenosis. FFR is the ratio of maximal blood flow through the stenotic coronary to maximal blood flow if the same coronary is normal. Although it is theoretically defined as the ratio of 2 flows, FFR is expressed as the ratio of distal coronary pressure (Pd), measured by an intracoronary pressure guidewire, and proximal coronary or aortic pressure (Pa), measured at the tip of the guiding catheter during maximal hyperemia, which is the prerequisite to obtain a linear relationship between coronary flow and pressure(Mangiacapra et al., 2018) it measures the coronary pressure between the distal to coronary artery stenosis and aortic pressure under conditions of maximum myocardial hyperemia, adenosine is administered before the FFR to get the accurate hyperemia

Coronary calcification is a very serious condition that mainly occurs due to the accumulation of plaque in the coronary arteries, it is not a one-day thing but mainly something that occurs with time. For a patient to have a blockage in the coronary artery it is something that has been built up for some time unlike thrombus blockage, atherosclerosis is plaque (fat and cholesterol) that has been building up in the artery for more than five years due to CKD, DM, high BMI, high blood pressure, high calcium level, high phosphate level, parathyroid hormone irregularities, family history of coronary artery calcification, use of cigarette smoking and tobacco and older age. As the plaque accumulates in the coronary arteries it causes less blood supply to the heart causing MI, based on the percentage of the blockage this is where the PTCA intervenes, and if it is heavily calcified that it becomes difficult to dilate with balloon angioplasty even with high-pressure inflation 3 that's when the rotational ablation comes in

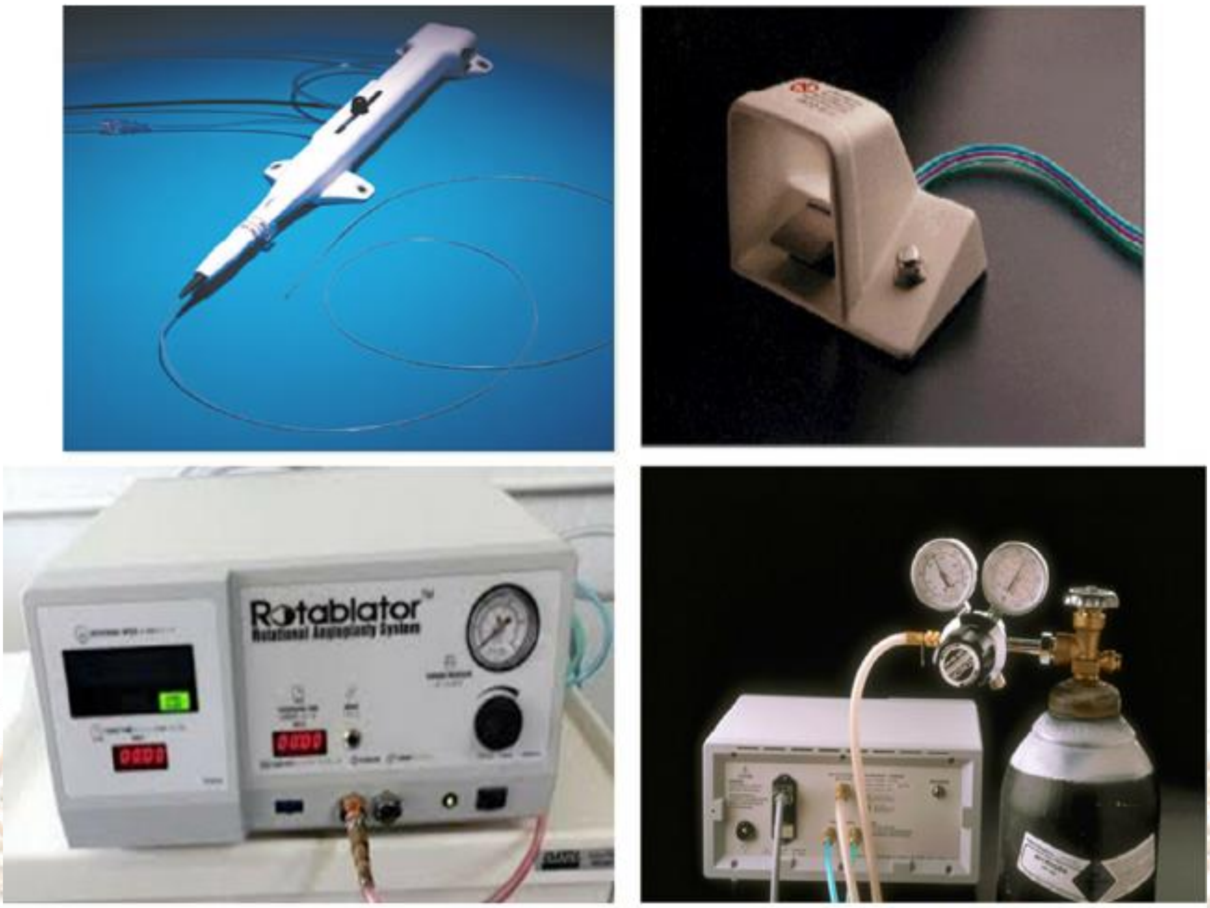
First used in 1989, rotational atherectomy is based on differential plaque removal by a rotating diamond-covered burr (Figure 1). The pulverized debris, 7.0---7.5 min diameter (the size of a red blood cell), is easily washed away. Additionally, this technique minimizes wall stress. (Cavusoglu et al., 2004)

ROTA is a therapy performed using a small rotating diamond-encrusted elliptical burr rotated at a speed of 140,000 to 180,000 rpm by a helical driveshaft that is advanced across the lesion over a guide wire. The burr causes differential cutting and preferentially ablates hard, inelastic, calcified plaque that is unable to stretch away from the rota burr compared with a healthy arterial issue. Using balloon and contrast angioplasty causes injury to the intima of the artery by compressing the plaque to the intima of the artery but by using rota it causes less tissue injury and causes smoother luminal surface and cylindrical geometry.(Mota et al., 2015; Moussa et al., 1997).

Figure 1. Boston Scientific Rotational atherectomy burr

The tools and technique of rota

The best-studied rotational atherectomy device is the Rotablator® (Boston Scientific, MN, USA). The system includes the Rotablator console and foot pedal, the RotaLink Advancer and burrs (1.25---2.5 mm), Rota Wire floppy or intermediate guidewire, RotaLink burr catheter, and compressed air or nitrogen at 7 atm with 140 l/min flow (Figure 2). The whole system is flushed by continuous saline infusion to avoid overheating, lubricate the tube and facilitate debris washout. It is recommended that each 500 ml of flush be prepared with heparin 5000 IU, verapamil 5 mg, and isosorbide dinitrate 5 mg. The whole system must be tested before advancing each burr. The console generates the energy to rotate the burr and controls the rotational speed, while the pedal switches burr rotation on and off, and also selects Dynaglide (low speed) or ablation mode. (Moussa et al., 1997)



courtesy of Boston Scientific ® Minnesota, USA

Figure 2. Rotational atherectomy device (Rotablator) components: RotaLink Advancer; Dynaglide pedal with on and off button; console with control of rotation speed; compressed air or nitrogen bottle and connections to the console.

The plaque material is removed with a small milling head fitted with diamond chips. The underlying physical principle is differential cutting. the atheromatous plaque is milled and atomized into small particles leaving a smooth surface

The second physical principle is the orthogonal displacement of force by rotating the milling head the force vector is shifted from longitudinal to orthogonal i.e., the friction between the rotablator and the guide wire is reduced as the friction between the milling head and the vessel wall which allows the system to be moved back and forth very easily during rotation so that even stenosis in heavily tortuous vessel segments can be achieved

There are various techniques for performing a rotablation, the single milling head strategy in which the plaque surface is removed with a small milling head (ratio of milling head/vessel diameter <0.6), and then a PTCA is always performed with a nominal pressure

In the multiple milling head strategy, milling heads of increased diameter are used one after the other up to a milling head/vessel diameter ratio of 0.9, if at all post-dilation is only done with very low pressure (< 2 atm) to reshape the treated segment

For post-dilation two techniques are used, post-dilation with a slightly oversized balloon at low pressure or post-dilation with a balloon matched to the vessel diameter and at nominal pressure whereby the post-dilation with low pressure leads to fewer dissection

Indications of rota

The principal indication for RA is modification of severely calcified de novo coronary stenoses which are unlikely to expand adequately with balloon angioplasty to allow for complete stent expansion. The detection of severe coronary calcification traditionally relied on fluoroscopy but it has been demonstrated that fluoroscopy is less sensitive in calcium detection compared with intravascular imaging(Mintz et al., 1995).

The indications for rotablation were angiographically severely calcified lesions. Severe calcification was defined as readily apparent radiopacities within the vascular wall at the site of the stenosis that was noted without cardiac motion before the contrast injection

Another good indication is ostium stenosis of the RCA which can only be treated with PTCA

The advantage of rotablation in the treatment of non-dilatable stenoses is undisputed. The stenoses that primarily cannot be dilated even with the highest pressure could be treated with rotablation with a success rate of 97.6% in 40/41 patients without complications. if there is no dissection and the rotablator wire can be used to pass the stenosis, the rotablation can also be performed immediately after the unsuccessful PTCA

Due to the physical principle, rotablation seems more suitable than PTCA for certain indications. The differential cutting allows a partial removal of the stenosis this can mean an advantage over PTCA in the calcified segment

contraindication

Rotablation should be performed carefully and cautiously in patients with reduced left ventricular function. Left ventricular decompensation can occur as a result of temporary wall movement disorder due to vascular spasm or delayed outflow of ablated material

Microcavitations, the formation of small gas bubbles caused by the high-frequency rotating milling head, also lead to wall movement disorders via the mechanism of peripheral embolization. If necessary, an Intra-aortic balloon pump should be placed prophylactically.

A dissection in the target vessel is another contraindication, since the rotating milling head may become lodged in the dissected vessel.

Also, the presence of a strongly pronounced vasospastic component of coronary heart disease should be regarded as a contraindication, since rotablation often leads to a spastic reaction in the treated vascular segment which can lead to vessel occlusion if there is a corresponding predisposition.

To avoid peripheral thrombosis caused by larger particles of ablated plaque, rotablation in vein bypass vessels should only be performed under the strictest indication in addition, because of the often-fragile wall of the atherosclerotic altered graft there is an increased risk of perforation of the vessel wall. Because of the risk of thrombus detachment and wall perforation, aneurysmically altered coronary vessels should be regarded as a contraindication.

complication

A rotablation is more time-consuming, expensive, and complex than the performance of a conventional PTCA and is characterized by some typical side effects and complications.

In the large studies on rotablation and the American register, the rates for the occurrence of severe cardiac events (transmural myocardial infarction, emergency ACVB surgery, and death).

After rotablation, there is almost always a spastic constriction of the vessel, which can lead to occlusion. Possible causes are vibrations, micro-cavitation, or heat generation of the milling head in the vessel. The occurrence of a severe Spasm has been described in up to 6.6% of cases. Concomitant intravenous spasmolytic treatment is required. A two-hour pre-treatment is suitable for this with nitroglycerin and nifedipine or the direct administration of nitroglycerine, Verapamil, and Liquimin via the rotablator catheter pressure, irrigation is suitable for this purpose. Refractory spasms occasionally react to the additional administration of morphine or alpha-1 blocker urapidil.

The occurrence of complications can be prevented by limiting the time of the individual milling intervals to a maximum of 20s, the accompanying spasmolytic treatment, and the avoidance of a drop in speed in the Stenosis by more than 5000 rpm during the milling intervals. A drop in speed below 150000 rpm leads to the appearance of big particles and thus an increased risk of peripheral embolization

Another complication that occurs more frequently with rotablation compared to other interventional procedures is the so-called "no-reflow" phenomenon. This is a delayed antegrade flow in the treated vessel (decrease of> 1 TIMI degree]). especially in heavily calcified stenoses or long-stretched stenoses that are very rich in material, the short-term accumulation of much-ablated stenosis material and/or large particle flow leads to delayed outflow into the periphery. The no-reflow phenomenon can be treated by forceful injection of blood to improve the antegrade perfusion or intracoronary administration of verapamil (50 to 800jag) are treated. The phenomenon is associated with an increased risk for the occurrence of Q-wave infarcts (7%) and nontransmural infarcts (26%) [14]. In this context Ron

Bradycardia and high-grade AV block occur with rotablation in the right coronary artery or more rarely in the circumflex ramus, this complication can easily be suppressed by the prophylactic administration of 0.5 to 1 mg atropine intravenously immediately before the first feeding interval Occasionally, however, a temporary pacemaker is required to be placed. The arrhythmias usually do not persist longer than 20 to 30 s after termination of the milling process.

A very rare complication is the perforation of the vessel by the milling head. This is not the case Of the exit of the milling head from the vessel, but obviously around the smallest holes in the vessel wall. leading to leakage of contrast medium. It is more commonly localized in the RCA and CFX than in the LAD.

Discussion

Although rotablation is a very complex procedure that requires high skillful person for it and has its complications such as perforation but based on STRATA and CARAT the number of people who happen to have restenosis when rota then PTCA was done is less compared to those who have done PTCA itself. It is clear that the burr breaks and smoothens the lumen of the artery from calcification more than PTCA which only compresses the calcification to the walls of the artery, since it’s also expensive, when necessary, rota should be done because not all calcifications require it, to avoid higher costs to the patient, the patient should be given all options and side effects and benefits for him to choose a pocket-friendly procedure

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