# INITIAL EXPERIENCE OF FRACTIONAL FLOW RESERVE IN 30 PATIENTS WITH MODERATE CORONARY ARTERY LESIONS AT ARMED FORCES INSTITUTE OF CARDIOLOGY

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## ABSTRACT

***Objective:*** To evaluate our initial experience of Fractional Flow Reserve (FFR) for decision making in coronary revascularization in moderate lesions.

***Study Design:*** A descriptive study.

***Place and Duration of Study:*** Armed Forces Institute of Cardiology/National Institute of Heart Diseases from August 2009 to August 2010.

***Patients and Methods:*** A total of 30 consecutive patients who underwent FFR at AFIC/NIHD from August 2009 to August 2010. These were the cases in which decision regarding PCI was difficult on visual assessment alone as experienced operators differed in their opinion. A 0.014" FFR wire was used and pressure gradients across the lesions were noted

***Results:*** A total of 30 patients with 44 moderate lesions on coronary angiography were evaluated in our initial experience. Amongst these, 27 (61.4%) LAD lesions were studied (20 lesions had an FFR > 0.80 while 7 (15.9%) had an FFR 0.80 or less). Seven (15.9%) lesions of LCX were evaluated (5 had an FFR > 0.80 and 2 had 0.80 or less). Seven (15.9%) lesions were of RCA (4 had an FFR >0.80, 3 had 0.80 or less). One case of LMS lesion was found to be non-critical. Two (4.5%) vein graft lesions were included of which one was found to be angiographically critical, (FFR 0.72). Out of the total 44 lesions studied 14 (31.82%) lesions were critical with an FFR 0.80 or less, which were stented. Thus 30 stents were saved. This reduced the cost, as well as the un-necessary hazards and risks associated with PCI and the issue of difference in opinion was put to rest.

***Conclusion:*** We thus conclude that FFR is a very important tool in guiding the interventionist for planning PCI in moderate lesions

**Keywords:** FFR, hyperemia, PCI.

## INTRODUCTION

Coronary angiography remains the most accurate morphologic assessment tool for measuring lumen of the epicardial coronary arteries[1]. However, the angiographic degree of stenosis on visual assessment is a poor tool to establish the functional significance of a given stenosis and a potential for inappropriate decision making remains during revascularisation of moderate coronary artery disesase (CAD) lesions[2,3]. The precise functional information is invaluable for treatment of patients with coronary artery disease. Fractional flow reserve (FFR) helps in the assessment of actual gradient across a lesion and gives its true functional assessment[4].

FFR based precutaneous coronary intervention (PCI) has been shown to be very useful in decreasing mortality and the cost associated with PCI alongwith improving the long term outcome by decreasing the incidence of major adversed cardiac event (MACE), as concluded in FAME TRIAL[4]. This technique is used in coronary catheterization to measure pressure difference across a coronary artery stenosis to determine the likelihood that the stenosis impedes blood flow, and thus oxygen delivery to the heart muscle causing myocardial ischemia.

Fractional flow reserve is defined as the pressure distal to a stenosis relative to the pressure proximal to the stenosis[5]. It is calculated from the ratio of simultaneously recorded mean aortic pressure (P1) and mean coronary artery pressure (P2) [FFR= (P1) - (P2)]. The result is an absolute number; an FFR of 1 is considerd to be 'normal', suggesting that there is no restriction of flow across the area of the vessel studied. An FFR of 0.50 means that a

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*Received: 05 Oct 2010; Accepted: 03 Aug 2011*

given stenosis causes a 50% drop in blood pressure across the stenosis[6]. Thus, FFR expresses the maximal flow down a vessel in the presence of a stenosis compared to the maximal flow in the hypothetical absence of the stenosis[7].

For FFR measurement, we used a 6F guiding catheter inserted via the femoral or radial artery. FFR is measured by a small sensor on the tip of a 0.014" PTCA guidewire (Volcano therapeutics Inc, Rancho, Cordova, USA). This determines the exact gradient across the lesion. FFR can be measured both at rest and during maximal blood flow or hyperemia which can be induced by injecting intra-coronary and I/V adenosine in an appropriate dose. A pullback can also be performed and pressures are recorded across the lesion.

There is no absolute cut-off point at which FFR becomes abnormal; rather, there is a smooth transition, with a large gray zone of transition[8]. In clinical trials however, a cut-off point of 0.75 to 0.80 has been used; higher values indicate a non-significant stenosis, whereas lower values indicate a significant lesion[9].

The main objective of this study was to evaluate all visually assessed moderately severe coronary artery lesions with the help of FFR and to look for its impact on results.

## PATIENTS AND METHODS

We carried out this study at the Armed Forces Institute of Cardiology/National Institute of Heart Diseases (AFIC/NIHD) from August 2009 to August 2010.

Thirty consecutive patients with moderate coronary artery disease on coronary angiogram having 60-80% stenosis on visual assessment were included. Patients found to have either a mild coronary artery disease with less than 40% stenosis or a severe disease with more than 80% stenosis on visual assessment were excluded. These patients had different therapeutic options suggested by the heart team because different operators graded the lesions differently. An FFR was performed. The decision to perform PCI was then based upon the FFR results.

Arterial access was used either using a femoral approach or a radial approach. Venous access was used via a large central vein for adenosine infusion to cause hyperemia in coronary circulation. A 6 French guiding catheter was engaged in the ostium of the coronary artery being evaluated. An intravenous injection of heparin (70 units/kg) was given. A pressure monitoring guide wire (Volcano therapeutics Inc, Rancho, Cordova, USA) with a pressure sensor located 3 cm from the tip, was set to zero, calibrated and then introduced into the guiding catheter. The pressure wire was then advanced further into the artery until the pressure sensor was placed 2 cm distal to the lesion. An FFR reading was obtained. If the reading was >0.80, myocardial hyperemia was induced by a continuous infusion of adenosine in a central vein at a rate of 140 microgram/kg/min for two minutes. During the period of maximum hyperemia, FFR was again recorded. If repeat FFR of the lesion was > 0.80, no intervention was performed and medical treatment was advised. If FFR was 0.80 or less, PCI with stenting was performed[10].

In these 30 patients, a total of 44 coronary lesions were evaluated by FFR. The lesions with an FFR of more than 0.80 were non-critical and did not require coronary stenting. On the other hand the coronary lesions with an FFR of 0.80 or less were hemodynamically critical, for which PCI with stenting was performed.

Data was analyzed using SPSS version 15. Descriptive statistics were used to describe the data.

## RESULTS

A total of 30 patients with 44 moderate angiographic lesions on coronary angiogram were evaluated in our initial experience of FFR. Twenty four (80%) patients were males while 6 patients (20%) were females. Mean age was 62.5 years (51-72 years). The various coronary arteries studied are shown in fig. The FFR results of various coronary arteries studied are shown in table.

In our initial experience of 44 lesions in 30 patients, FFR of 30 (68.18%) lesions was more than 0.80. They were advised medical

management. The remaining 14 (31.82%) lesions had an FFR of 0.80 or less. PCI was performed in all these cases. Thus, out of 44 studied lesions only 14 lesions required stenting. The use of FFR makes its utility even more important in our institute. This reduces the cost, as well as the un-necessary hazards and risks associated with PCI.

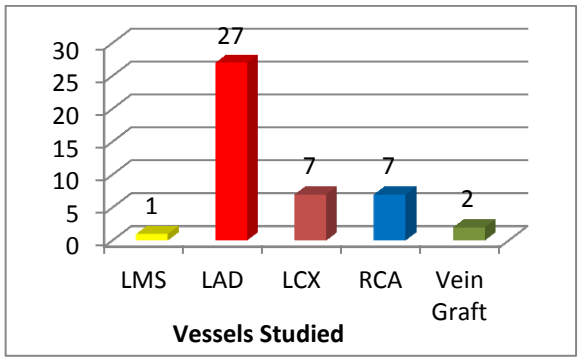


**Figure: Description of various coronary arteries (n=30).**

**Table: Description of FFR in relation to different coronary arteries. .**

| | FFR < 0.80 | FFR > 0.80 |
|---|---|---|
| LMS (n= 1) | 1 (100%) | 0 (0%) |
| LAD (n=27) | 7 (25.93%) | 20 (74.07%) |
| LCX (n=7) | 2 (28.60%) | 5 (71.40%) |
| RCA (n=7) | 4 (57.14%) | 3 (42.86%) |
| VG (n=2) | 1 (50%) | 1 (50%) |

## DISCUSSION

FAME Trial (FFR versus Angiography for Multivessel Evaluation) was a large randomized multicentered trial in which investigators randomized 1005 patients to either angiography guided PCI, or FFR guided PCI[11]. It was concluded that FFR guided PCI reduced the rate of composite endpoint of death, MI, or repeat revascularization by 30%[12] at one year, and reduced mortality and myocardial infarction by 35% at one year. At two years follow-up of FAME trial the FFR guided PCI arm still had a significant reduction of primary end points as compared to the conventionally treated arm[13]. It was further concluded after two year follow-up that FFR guided PCI was cost-saving and reduced revascularization procedures[14].

Our clinical experience shows that in patients with moderate stenoses, measurement of FFR is useful in decision making before PCI and stenting. No study was available from Pakistan with which we could compare our results. However, in a similer study carried out at Korea by Nam et al, the invstigators found that FFR based PCI strategy for intermediate coronary artery disease was associated with a favourable outcomes. The FFR based PCI reduced the need of revascularization of many of these lesions. The study included 167 patients, with intermediate coronary lesions evaluated by FFR. Cut off value of FFR in FFR-guided PCI was 0.80. The results of that study were however quite comparable to our study[15].

The concept of FFR is quite old. In 1996 Pijls and Bruyne published an article in N Engl J Med mentioning the measurement of FFR to assess the severity of CAD[16]. In this era of expensive drug-eluting stents, a cost-effective strategy may include the determination of the haemodynamics of a stenosis in the catheterisation laboratory before stenting, especially in the management of patients with multivessel disease[17]. It is important to know which lesions should be stented and which might be left alone[18]. PCI with stenting to ischaemia producing arteries improves symptoms and outcomes, but stenting to non-iscaemia producing arteries has no benefit compared to medical treatment only[19] and may even be harmful. Haemodynamic studies can reduce the number of stents used and overall medical expenditures[20].

## CONCLUSION

We thus conclude that FFR is helpful in guiding the interventionist for planning PCI in moderate lesions. This helps in reducing the extra cost of the procedure by avoiding un-necessary stenting of insignificant lesions and thus also prevents un-necessary hazards of PCI and dual anti-platelet therapy.

## REFERENCES

1. Kwon Lee B, Hee Choi H, Hong KS, Kim BK, Shim J, Kim JS, Ko YG, Choi D, Jang Y, Hong MK. Clin Cardiol. 2010 Aug;33(8):490-4.
2. Nam CW, Yoon HJ, Cho YK, Park HS, Kim H, Hur HS, JACC Cardiovasc Interv. 2010 Aug, 3 (8): 812-813.)
3. Tonino PA, Fearon WF, De Bruyne B, Oldroyd KG, Leesar MA, Ver Lee PN, Maccarthy PA, Van't Veer M, Pijls NH. J Am Coll Cardiol. 2010 Jun 22;55(25):2816-21.

4. Tonino PAL, De Bruyne B, Pijls NH, et al. Fractional flow reserve versus angiography for guiding percutaneous coronary angiography. N Engl J Med 2009; 360: 360: 213-224.

5. Mamas MA, Horner S, Welch E, Ashworth A, Millington S, Fraser D, Fath-Ordoubadi F, Neyses L, El-Omar M. J Invasive Cardiol. 2010 Jun;22(6):260-5.

6. Botman KJ, Pijls NH, Bech JW, et al. Percutaneous coronary intervention or bypass surgery in multivessel disease? A tailored approach based on coronary pressure measurement. Catheter Cardiovasc Interv. 2004;63(2)184-191.

7. Jiménez-Navarro MF, Alonso-Briales J, Hernández-Garcia JM, et al. Usefulness of fractional flow reserve in multivessel coronary artery disease with intermediate lesions. J Interv Cardiol. 2006;19(2):148-152.

8. Wongpraparut N, Yalamanchili V, Pasnoori V, et al. Thirty-month outcome after fractional flow reserve-guided versus conventional multivessel percutaneous coronary intervention. Am J Cardiol. 2005;96(7):877-884.

9. Berger A, Botman KJ, MacCarthy PA, et al. Long-term clinical outcome after fractional flow reserve-guided percutaneous coronary intervention in patients with multivessel disease. J Am Coll Cardiol. 2005;46(3):438-442.

10. Lindstaedt M, Fritz MK, Yazar A, et al. Optimizing revascularization strategies in patients with multivessel coronary disease: impact of intracoronary pressure measurements. J Thorac Cardiovasc Surg. 2005;129(4):897-903.

11. Koo BK, Kang HJ, Youn TJ, et al. Physiologic assessment of jailed side branch lesions using fractional flow reserve. J Am Coll Cardiol. 2005;46(4):633-637.

12. Bellenger NG, Swallow R, Wald DS, et al. Haemodynamic significance of ostial side branch nipping following percutaneous intervention at bifurcations: a pressure wire pilot study. Heart. 2007;93(2):249-250.

13. Lindstaedt M, Spiecker M, Perings C, et al. How good are experienced interventional cardiologists at predicting the functional significance of intermediate or equivocal left main coronary artery stenoses? Int J Cardiol. 2007;120(2):254-261.

14. Pijls NH, De Bruyne B, Bech GJ, et al. Coronary pressure measurement to assess the hemodynamic significance of serial stenoses within one coronary artery: validation in humans. Circulation. 2000;102(19):2371-2377.

15. Nam CW, Yoon HJ, Cho YK, Park HS, Kim H, Hur HS, JACC Cardiovasc Interv. 2010 Aug, 3 (8): 812-813.)

16. Pijls NH, De Bruyne B, Peels K, et al. Measurement of fractional flow reserve to assess the functional severity of coronary-artery stenoses. N Engl J Med. 1996;334(26):1703-1708.

17. Lindstaedt M, Yazar A, Germing A, et al. Clinical outcome in patients with intermediate or equivocal left main coronary artery disease after deferral of surgical revascularization on the basis of fractional flow reserve measurements. Am Heart J. 2006;152(1):156.e1-9.

18. G. S. Werner, R. Surber, M. Ferrari, M. Fritzenwanger, and H. R. Figulla
The functional reserve of collaterals supplying long-term chronic total coronary occlusions in patients without prior myocardial infarction Eur. Heart J., October 2, 2006; 27(20): 2406 - 2412.

19. McClish JC, Ragosta M, Powers ER, et al. Effect of acute myocardial infarction on the utility of fractional flow reserve for the physiologic assessment of the severity of coronary artery narrowing Am J Cardiol 2004;93:1102-1106.

20. Tonino PA, De Bruyne B, Pijls NH, et al (January 2009). "Fractional flow reserve versus angiography for guiding percutaneous coronary intervention". N. Engl. J. Med. 360 (3): 213–24.

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