Research Article

Angiographic versus hemodynamic severity of coronary artery stenosis: an experience of Iraqi centre for heart diseases.

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Abstract

Background: It can be difficult to determine on the coronary angiogram which lesions cause ischemia. Revascularization of coronary stenosis that induces ischemia improves a patient's functional status and outcome. For stenosis that does not induce ischemia; however, the benefit of revascularization is less certain. Fractional flow reserve is an important tool that measures the functional significance of lesions.

Objectives: To find out the relationship between angiographic and hemodynamic severity of coronary artery stenosis.

Methods: Twenty three patients with 28 coronary artery stenoses were included in the study. Significant anatomical lesion was defined as a diameter stenosis≥ 50%of arterial lumen; while non-significant lesions were defined as any lesion with a diameter stenosis < 50% of arterial lumen. Significant lesions were further subdivided into: intermediate lesions (50-70%) reduction in diameter stenosis, and critical lesions (71-90%) diameter stenosis. Then all lesions are assessed by fractional flow reserve in order to determine their hemodynamic significance. Lesions were considered functionally significant depending on FFR ≤0.80 as a cut off value.

Results: In angiographically non-significant group lesions only one patient (14%) were functionally significant after assessment by fractional flow reserve. While in intermediate group lesions six patients (40%) were functionally significant with a p value 0.243. In critical lesions five patients (83%) were functionally significant with a p value 0.025.Of all lesions 12 lesions (42%) were functionally significant

Conclusion: Fractional flow reserve is an important tool to influence decision and change strategy of management at catheterization laboratory especially for intermediate lesions and even for sever lesions in a way that may be cost effective.

Key words: Fractional flow reserve, Significant coronary lesions, Quantitative coronary angiography

INTRODUCTION

Since the introduction of coronary angiography, various methods have been introduced to assess the severity of stenosis in coronary arteries. The most simple and frequently used method is the visual estimation of the percentage of stenosis. Visual estimation tend to overestimate stenosis prior to percutaneous coronary intervention (PCI) and to underestimate post-PCI stenosis.[1] Multiple views are important, because many lesions have a markedly eccentric, elliptical rather than round lumen . Any such suspicious lesion must be examined in a variety of other projections to reveal their true severity and to distinguish the lucency caused by eccentric stenosis from a similar lucency that may be caused by tortuosity or overlapping vessels in the absence of any true abnormality at the site through a perceptual artifact known as the Mach effect.[2]

In addition to the difficulty in finding a disease-free reference segment, the major problem in the interpretation of a coronary angiogram is deciding the severity of any given stenosis.[3] Both animal data and human data show that a stenosis that reduces the lumen diameter by ≥ 50% is hemodynamically significant. It reduces the normal threefold to fourfold flow reserve of a coronary bed.[4] Although the process of visual estimation of the degree of coronary stenosis may seem straightforward it is subjected to significant operator variability. A stenosis that measures 50% may thus typically be called 70%, whereas a stenosis that measures 70% may be called 90 %.[5]

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Different tools were tried to resolve this problem. The simplest is the quantitative coronary angiography (QCA), which reduces the standard deviation for diameter stenosis to 6-8%.[6] However, the severity of coronary stenosis calculated by QCA does not always correlate with the clinical presentation of related symptoms.[7]

In1996, fractional flow reserve (FFR) measurement was introduced. This technique was pioneered by Pijls.[8] The approach assumes linearity of the vasodilated pressure-flow relationship, which is known to be curvilinear at reduced coronary pressure.[9] They are attractive in that they can immediately assess the physiologic significance of an intermediate stenosis. It can also be used to assess the functional effects of a residual lesion after percutaneous coronary intervention.[10]

Now considerable prognostic information, indicating that FFR measurements more than 0.80 are associated with excellent outcomes with deferred rather than prophylactic intervention.[11] So physiologically guided PCI using FFR versus angiographic criteria is safe, cost-effective and reduces the number of stents required to treat patients with multi-vessel coronary artery disease.[12] An FFR value of ≤ 0.80% identify ischemia causing coronary stenosis with accuracy of >90%. For this reasons FFR measurement has become an indispensable tool for decision-making in patients with coronary artery disease.[13-16] This study is designed to find out the relationship between angiographic and hemodynamic severity of coronary artery stenosis in an Iraqi tertiary cardiac centre.

METHODS

This is a comparative study conducted at Iraqi Center of Heart Diseases in Baghdad during the period from May 2012 to May 2013. Iraqi Centre of Heart Diseases is one of the major tertiary cardiac centres in Iraq. Twenty-three patients were enrolled in the study. Those patients were admitted to the Centre for performing elective coronary angiography. All heamodynamically stable patients presented on Sundays were included in this study.

Patients with acute myocardial infarction (AMI) and acute coronary syndrome (ACS) were excluded because the microvascular bed in the infarct zone may not have a uniform, constant, or minimal resistance. The severity of stenosis may also evolve as thrombus and vasoconstriction fade away. In addition FFR measurements are not meaningful when normal perfusion has not been achieved in the artery.[17,18]

Lesions with a diameter of stenosis ≥ 90 % of the luminal diameter have been excluded because many studies have stated that subtotal coronary artery stenosis do not need FFR in the decision making of revascularization.[19]

The FFR is defined as the ratio between distal coronary pressure and aortic pressure. Both measured simultaneously at maximal hyperemia (pd/pao) where pd means distal coronary artery pressure and pao means pressure in the aortic artery. Distal coronary pressure was measured with coronary pressure guide wire.[12]

Catheters: Diagnostic catheters have been avoided though they were technically feasible. Because high levels of friction would hamper wire manipulation also the small internal caliber would interfere with pressure measurements, so guided catheters were used.

We used ST. JUDE MEDICAL wire. A specific solid state sensor mounted on the guide wire, (**figure 1**), was used to measure intracoronary pressure. The sensor is located at the junction between the 3 cm long radiopaque tip of the wire and its remainder.

Anticoagulation is routinely used in form of unfractionated heparin, in a dose of 40-60 IU/kg once the sensor guide wire is passed through an angioplasty Y-connector attached to the guiding catheter.

All lesions were assigned by two interventional cardiologists into non-significant, intermediate and critical lesions using visual estimation. The lesion is assigned non-significant if the stenotic ratio is < 50% of the luminal diameter of the artery, and it is intermediate or critical if the stenotic ration is 50-70 % and 71-90 % of the luminal diameter respectively.

Then pressure sensor wire connected to system pressure analyzer(ST.JUDE MEDICAL)in order to measure hemodynamic effect of lesions. Wire is pushed distal to stenosis with pressure sensor about 2 cm distal to the lesion; maximal hyperemia was then induced by adenosine administered by intracoronary bolus injection of 40 microgram for right coronary artery (RCA) and 60 microgram for left coronary artery (LCA). The dosage in the LCA may be simply increased to maximum of 150 microgram if there is a serious doubt about the result. Effect of intracoronary adenosine will peak in ≤10 second with a plateau phase duration in less than 10 second. During the procedure coronary spasm is avoided, as the case in every intracoronary procedure, by administering 200-300 microgram of nitroglycerine in the coronary artery prior to entering it with any device. The Pd and Pa are continuously recorded. FFR is then calculated as Pd/Pao at maximal hyperemia. Lesions considered functionally significant when FFR ≤0.80 %.[20]

Statistical analysis:

Data were analyzed using SPSS software for window, version 17.0. Fisher Exact test is used to test the significance of the results. The results were considered statistically significant if the p value < 0.05.

RESULTS

Twenty three patients were included, with 28 lesions. Mean age of the sample was 52.26 years. **Table 1** shows demographic characteristics of the study group. Distribution of hemodynamic significance of lesions using FFR have been shown in (**table 2**).

Figure 2 shows a significant inverse correlation between diameter of stenosis of the lesion and the FFR.

Table 1: Demographic and baseline characteristics		Number	%
Total number of Patients		23	
Total number of lesions		28	
Gender	Male	18	78.26
	Female	5	21.74
Mean age/ year		52.26	
Patient with hypertension		9	39
Patients with diabetes		12	52
Current smoker		8	34
Positive family history of IHD		9	39
History of MI		10	43.4
History of previous PCI		7	30.4

Figure 1: Sensor mounted guide wire

Table 2: Distribution of hemodynamic significant lesions using FFR cut off 0.80, according level of angiographically assessed stenosis.

Angiographic Stenosis Groups		Fractional Flow Reserve (FFR)			
		≤0.80		>0.80	
	Total	No	%	No	%
Critical (71-90% diameter stenosis)	6	5	83.3	1	16.7
Intermediate(50-70%diameter stenosis)	15	6	40.0	9	60.0
Non-significant(<50%diameter stenosis)	7	1	14.3	6	85.7
Critical lesion: p value 0.025*, Intermediate lesion: p value 0.243*					
*Significant using Fisher Exact test at 0.05 level					

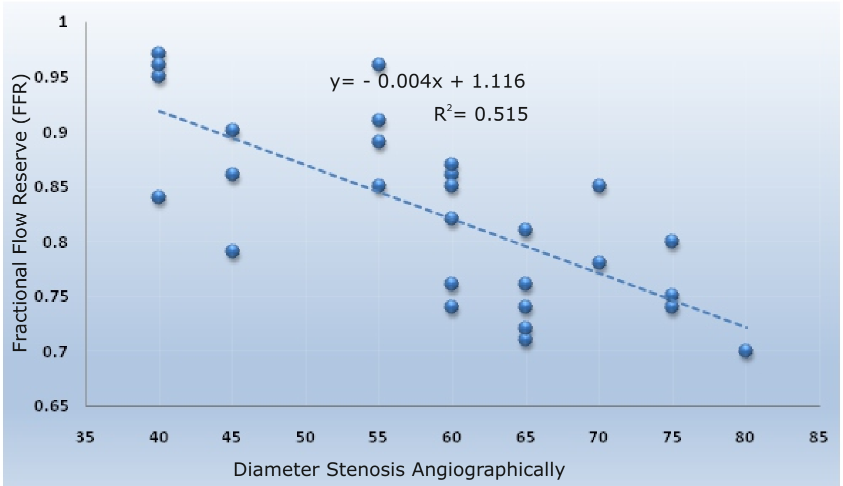

Figure 2: Scattered plot shows significant inverse relationship between diameter of stenosis and FFR.

DISCUSSION

The study assessed 28 lesions by coronary angiography and FFR through using pressure wire. Nine lesions (60%) of intermediate group and one (16.7%) of critical group were found to have no hemodynamic significance.

The principal finding in our study is that 40% of the lesions of intermediate group were found to have significant hemodynamic ischemia that is to say it would require intervention. This is comparable with other studies, Pim A. L. Tonino et. al. (FAME Study),[19] W. Bop Meijboom et. al, and [21] Joshua J Fischer et al.[22] The difference between hemodynamically and non-hemodynamically significant intermediated lesions is statistically non-significant; P value is 0.243. The reason can be attributed to small size group, 15 lesions. Despite this statistical result, measurement of FFR may potentially preclude doing unnecessary interventions for about 60 % of intermediate lesions, so this process may carry remarkable clinical impact on personal and economical level.

For critical lesions, five (83.3%) of them were functionally significant depending on a cut off value of (≤0.80),[20] which gives a significant statistical association between CCA and FFR in this specific group (p-value 0.025). This also shows that even when a lesion is classified as being critical angiographically, FFR is still having a role, though very small, to decrease the cost and morbidity of unnecessary further intervention. Of angiographically critical lesions, 1 (16%) was discovered to be hemodynamically non-significant lesion. Although our sample is very small to be compared to other studies, our result is comparable to that of Pim A L Tonino et. al.[19] (FAME study) that found 104 out of 513 (20%) critical lesions were hemedynamicall non-significant by FFR measurement.

So in patients with coronary artery disease whether or not clinical data are taking into account one cannot rely completely on coronary angiogram to identify ischemia–producing lesions when assessing stenosis between 50% and 70%. The challenge, in fact, lies in that CCA provides a two dimensional planar silhouette of the arterial lumen, giving limited accuracy in the setting of vessel tortuosity, overlap, bifurcational, eccentric lesions or diffusely diseased arteries. In addition to interobserver as well as intraobserver variability in the angiographic assessment (the standard deviation for repeat estimation is 18%).

In other words, this study shows that the ability of coronary angiography to diagnose a functionally significant lesion depends highly on the group being assessed, as the correlation between FFR and coronary angiography is more significant in the critical group of lesions (p value 0.025) than the correlation in the intermediate lesions group (p value 0.243). In addition, we demonstrated a strong inverse overall correlation between angiographic diameter of stenosis and FFR (r -0.718, p value 0.0001), this is in concordance with J. S. Wijpkema et. al study [23] (r -0.46, p value 0.0006).

There are some limitations in this study which prevent us from formulation a recommendation to be followed universally in our daily practice in Iraq. The first is small size group of our study which was mainly due to shortage of time in the catheterization laboratories in our centre taking into account the long list of patients waiting for coronary angiography. The second is that this procedure is new and good training for doctors and technicians is needed to master it.

CONCLUSION

Fractional flow reserve is an important tool to influence decision and change strategy of management at catheterization laboratory especially for lesions classified angiographically as being intermediate. Management of critical lesions can also be affected by FFR to some extent. Large size studies are needed to test the clinical and economic significance of these results.

RECOMMENDATION

1. Stress more on the role of hemodynamic assessment of lesions not only in intermediate lesions but also in critical lesions.
2. Consider FFR measurement a routine in catheterization laboratories daily work for intermediate and severe coronary lesions.
3. Performing larger study in future with expansion in bothpatients number and diameter of lesions assessed to confirm or disconfirm our result.

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