Original article

Threshold parameters of left main coronary artery stem stenosis based on intracoronary ultrasound examination

Robert J. Gil[1], Aneta I. Gziut[1], Francesco Prati[2], Adam Witkowski[3], Jacek Kubica[4]

[1]Department of Invasive Cardiology, Central Hospital of Ministry of Internal Affairs and Administration, Warsaw, Poland

[2]European Imaging Laboratory, Rome, Italy

[3]Cardiac Institute, Warsaw, Poland

[4]Cardiac and Internal Clinic, Collegium Medicum, Bydgoszcz, Poland

Abstract

Introduction: The left main coronary stem (LMS) provides blood supply to the left ventricle, and its stenosis is associated with serious clinical consequences. The accurate assessment of LMS stenosis determines appropriate treatment and long term prognosis. So far no criteria have been established to correctly estimate the magnitude of problematic lesions as indicated by quantitative angiography (QCA).

Aim: An attempt to establish intracoronary ultrasound (ICUS) threshold values of significant LMS stenosis.

Methods: The studied group consisted of 197 patients (mean age 69.72±8.51) who underwent percutaneous coronary intervention (PCI) of the left coronary artery. Group 1 (G1) consisted of 99 patients who had LMS diameter reduction (%DS) of less than 30%. Group 2 (G2) consisted of 77 patients with %DS between 30% and 50%, and the remaining 21 patients with %DS higher than 50% were classified as Group 3 (G3).

The quantitative angiography (QCA) analysis included lumen diameter (Ldmin) which was LMS lumen diameter at the most stenotic segment as well as LMS diameter reduction (%DS).

The parameters that were analysed during ICUS study included maximum plaque burden (%) (Pbmax), minimal lumen area (LAmin) and lumen stenosis (%LS) calculated according to the formula: (LAmin/LAref) x 100%. Additionally, correlations between the corresponding parameters measured using QCA and ICUS were investigated.

Results: Both diagnostic techniques showed the most advanced degree of atherosclerosis in G3. All the G3 patients and 5 G2 patients had MLD values less than or equal to 2mm.

In G1 LAmin values exceeded 9 mm^2 in all patients, whereas among G2 patients 12 (15.5%) had LAmin lower than 6 mm^2, 29 pts. (37.66%) within the range of 6-9 mm^2 and in the remaining 36 pts. (46.75%) it exceeded 9 mm^2. In G3 LAmin values in 17 pts. (80.95%) did not exceed 6 mm^2 and in the remaining 4 pts. (19.05%) were slightly higher. Lumen reduction higher than 50% was noted in all G3 patients and 3 G2 patients (in all these 3 G2 patients LAmin values were lower than 6 mm^2). All G3 pts. and 3 G2 pts. with LAmin value <6mm^2 and %LS >50% had angina and a positive stress ECG test. All of these patients (n=24) underwent LMS stent implantation.

Conclusions:

1. Minimal lumen diameter of LMS ≤2mm in quantitative angiography indicates a very high probability of significant stenosis of this vessel.
2. Ultrasound data analysis shows that besides LMS lumen area (<9 mm^2) stenosis significance is determined by lumen reduction of more than 50%.

Key words: left main stem, intracoronary ultrasound, coronary artery disease, coronary stenting

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Address for correspondence:

Prof. Robert J. Gil, Klinika Kardiologii Inwazyjnej, Centralny Szpital Kliniczny MSWiA, ul. Wołoska 137, 02-507 Warszawa, tel.: +48 22 508 11 00, fax: +48 22 508 11 77, e-mail: kardiologia.inwazyjna@cskmswia.pl

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Introduction

The most important human epicardial artery is the left main coronary stem (LMS), which divides into 2 branches: the left anterior descending artery (LAD) and the left circumflex artery (LCX). Both of them are responsible for the blood supply of 80% of the left ventricular free wall, apex and interventricular septum [1, 2]. Many years of experience and clinical follow-up have shown that long term results in patients with LMS stenosis treated non-invasively are poor as far as life expectancy (approximately half of them die within 5 years of the diagnosis) and presence of recurrent acute coronary syndromes are concerned [3-9]. This type of stenosis even has its own nickname – the "widow maker". Therefore, diagnosis of significant LMS stenosis (%DS >50) in coronary angiography, if not followed by revascularisation, is associated with much poorer prognosis [1-3].

Significant stenosis of LMS is diagnosed in 7-10% of all angiographic examinations performed. Unfortunately, correct assessment of the degree of stenosis is not always easy and very often there are two different interpretations of the same study. Such differences may be caused by too deep angiographic catheter placement with various plaque location, contrast leakage to aorta, wrong picture view showing the vessels "sitting on each other" and finally by diffuse atherosclerotic plaques making it difficult to choose the referral segment.

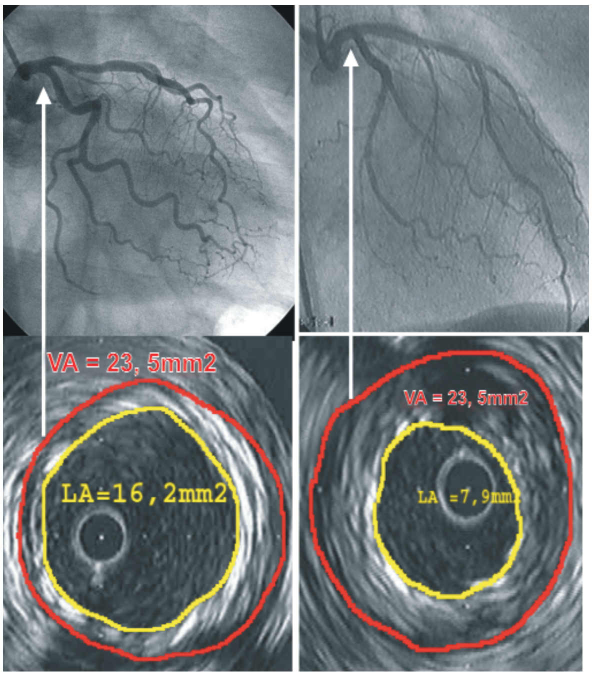

Figure 1. Coronary angiography of LMS – above, Intracoronary ultrasound of LMS- the same segment – below

Remodelling of the LMS and its effect on the vessel diameter also has to be considered [7-9].

All the doubts mentioned above can be solved with the use of intracoronary ultrasound (ICUS). This procedure allows precise assessment of severity of the atherosclerotic process (Figure 1) and accurate atherosclerotic plaque morphology evaluation, and helps to measure the true dimensions of the coronary vessel [10-15]. Despite the wide acceptance of ICUS as a method aiding qualification and optimisation of the revascularisation procedure, performing ICUS for the assessment of atherosclerotic lesions within LMS is still controversial. One reason is the lack of widely accepted criteria for the identification of significant LMS lesions.

The aim of our study was to define threshold ultrasound parameters able to identify significant LMS stenosis in patients with coronary heart disease.

Methods

Patients. Retrospective analysis of 197 ICUS examinations (mean age 69.72±8.51 years), performed in patients with coronary heart disease, was done. Among them 176 had a percutaneous coronary intervention (PCI) involving the medial segment of LAD or LCX – distally to the first marginal branch. The remaining 21 patients had an ICUS examination performed before elective PCI of LMS. In the second group, no significant lesions of the remaining vessels were found, except in 4 patients. Table I shows the clinical characteristics of patients.

The main indication for ICUS was an attempt to optimise PCI strategy (balloon angioplasty alone or stent implantation) as well as to assess early results of the procedure. All PCI procedures were successful and no direct complications were observed. Patients with an acute myocardial infarction and with occluded or significantly stenosed proximal LAD or LCX were excluded from the study. The studied population was divided into 3 groups according to the severity of stenosis measured using quantitative angiography (QCA). LMS diameter stenosis (%DS) was calculated according to the formula: %DS=(1-MLD/RD) x 100%.

Group 1 (G1) consisted of 99 patients with LMS diameter reduction less than or equal to 30% (%DS <30%). LMS stenosis of between 30% and 50% classified 77 patients into group 2 (G2). The remaining 21 patients with LMS stenosis above 50% (%DS >50%) were included in group 3 (G3). In our study we assumed that %DS <30% represents mild atherosclerotic lesions, %DS between 30% and 50% moderate lesions, and %DS >50% severe atherosclerosis. According to the current guidelines presence of severe LMS atherosclerotic lesions was per se an indication for PCI.

Quantiative angiography. The quantitative analysis involved the vessel diameter in the most stenotic

Table I. Patient characteristics

Parameter	Group 1 (n=99)	Group 2 (n=77)	Group 3 (n=21)
Diabetes mellitus	11 (11.1%)	6 (10.4%)	6 (28.6%)
Dyslipidemia	36 (36.4%)	39 (50.7%)	12 (57.1%)
Smoking	28 (28.2%)	33 (42.9%)	10 (13%)
Hypertension	36 (36.3%)	43 (55.8%)	11 (52.4%)
Family history of CAD	18 (18.2%)	17 (22.1%)	8 (3.8%)
Previous myocardial infarction	29 (29.3%)	42 (55.8%)	9 (42.9%)
Unstable angina pectoris	18 (18.2%)	21 (27.3%)	6 (28.5%)
Two-vessel disease	25 (25.2%)	22 (28.6%)	4 (19%)

Abbreviations: CAD=coronary artery disease

segment (MLD) and appropriate reference diameter (RD) measured using the CASS II system featured with automatic vessel edge detection function (Pie Medical Data, Maastricht, NL).

ICUS examination. ICUS was performed prior to the therapeutic part of the revascularisation procedure in accordance with the guidelines of the European Society of Cardiology [16], accepted also by the American College of Cardiology, the American Heart Association and the Society for Cardiac Angiography and Interventions [17].

The ultrasound pictures were recorded live in digital format and stored in the computer memory or as analogue VHS tape recordings. The analysis of ICUS pictures involved the whole LMS and was performed in a single centre by two experienced specialists (A.I.G., R.J.G).

ICUS examinations were performed using the ClearView mechanical device system (Boston Scientific Co.) equipped with an angiographic catheter Atlantis operating at the acoustic frequency of 40 MHz (n=162) and an electronic InVision Imaging System (JOMED Inc.) equipped with an Avanar ultrasound catheter operating at the variable frequency of 18-26 MHz (n=35). When the JOMED system was used, the quantitative analysis of studied sections was performed based on the freeze frame pictures retrieved from optical disks, utilizing integral system software. ICUS pictures acquired using the Boston Scientific system were analysed using the three dimensional EchoPlaque system (INDEC System, USA) for picture reconstruction that enabled longitudinal and horizontal measurements of the arterial segments.

Cross sections were measured at 1 mm intervals of the analysed segments. The following parameters were included in the analysis:

PBmax (maximal plaque burden [%]) – residual value of atherosclerotic plaque burden at the point of maximum stenosis of the studied segment. PB stands for assessed degree of artery stenosis with ICUS, calculated from the formula PB = PA/VA x 100%, where PA = surface area of atherosclerotic plaque, VA = surface area of the vessel.

LDmin (minimal lumen diameter [mm]) – vessel diameter at the point of maximum stenosis

LAmin (minimal lumen area [mm^2]) – lumen area of vessel cross section at the point of maximum stenosis

LAref (reference lumen area [mm^2]) – lumen area at the reference point

VDref (reference vessel diameter [mm]) – diameter of the artery at the reference point which is the point of minimal residual atherosclerotic plaque

%LS (% lumen stenosis) – artery lumen reduction calculated from the formula: %LS=(1-LAmin/LAref) x 100%.

Follow-up. All the patients involved in the study were followed for 12 months. In the case of any angina symptoms the ECG stress test was performed. The positive stress test qualified the patient for a control coronary angiography. Additionally, all the patients after LMS stent implantation had follow-up angiography 3 months after the procedure.

Statistical analysis

Measured values of vessel diameters and lumen areas were expressed as mean values ± standard deviations. Normal distribution of experimental data was tested using the Shapiro-Wilk test. Potential correlations between studied parameters were investigated using multiple linear regression. Results were considered significant at $p<0.05$. Statistica 5.0 PL software was used for the statistical analysis.

Results

Analysis of reference diameters (RD and VD) in the studied group, regardless of the diagnostic tool used, showed the highest values in G1 and the lowest in G3. The values of vessel diameter measured using ICUS

Table II. Comparison of the coronary artery reference diameters assessed using quantitative angiography and intracoronary ultrasound

	RD (mm)	VDref (mm)	p
Group 1	4.92±0.67	5.51±0.63	<0.05
Group 2	4.71±0.71	5.32±0.90	<0.05
Group 3	3.80±0.31	4.80±0.81	<0.01

Table III. Comparison of the magnitude of artery lumen reduction assessed using quantitative angiography and intracoronary ultrasound

	%DS (%)	PBmax (%)	p
Group 1	17.18±4.62	30.45±6.85	<0.00001
Group 2	45.22±12.51	56.48±8.73	<0.005
Group 3	59.34±8.15	78.23±8.91	<0.0001

Table IV. Comparison of minimal vessel diameter assessed using quantitative angiography and intracoronary ultrasound

	MLD (mm)	LDmin (mm)	p
Group 1	3.95±0.97	4.30 ±0.72	<0.05
Group 2	3.22±0.73	3.62±0.68	<0.05
Group 3	1.58±0.78	2.00±0.59	<0.01

were significantly higher than using QCA (Table II). In the studied population an intermediate level of correlation between these parameters was found (R=0.36 p=0.00023). Analysis of such correlation in each group proved that in G1 it was the most significant (R=0.58 p=0.002), in G3 the power of the correlation was intermediate (R=0.32 p=0.0005) and in G2 no correlation between RD and VD could be found.

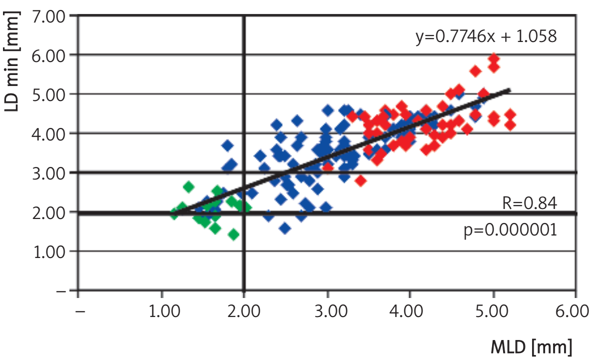

Figure 2. The correlation between minimal artery diameters measured using the two methods in the studied population

In the studied population the values of the parameters reflecting atherosclerosis severity, both in angiographic assessment (%DS) and ultrasound examination (Pbmax), increased from the lowest in G1, to medium in G2 to the maximum in G3, where the lesions were most severe (Table III).

Also the minimal lumen diameter of LMS in both QCA (MLD) and ICUS (LDmin) decreasea along with the severity of atherosclerosis – the highest values of these parameters were found in G1 and the lowest in G3. Significantly higher values of minimal vessel lumen diameter were observed in ICUS than in QCA (Table IV).

There was a strong correlation (R=0.84 p=0.00001) between minimal vessel diameter (MLD) measured using QCA and (LDmin) measured using ICUS (Figure 2). This correlation was very strong in G1 (R=0.71), strong in G2 (R=0.52) and absent in G3. MLD analysis of individual values showed that all G3 and five G2 patients had values ≤2 mm. However, in 2 patients of G2 ICUS study did not confirm the need to perform PCI.

The mean value of minimal LMS lumen area (LAmin) was also analysed. The value of this parameter was the lowest in G3 and differed significantly from G1 and G2, whereas LAmin in G1 was significantly higher than in G2 (Figure 3).

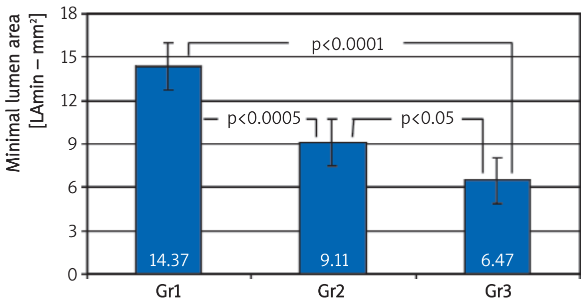

Figure 3. Comparison of minimal lumen area in the studied groups of patients

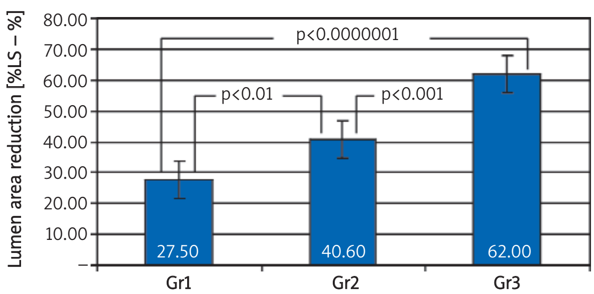

Figure 4. Comparison of lumen area reduction in the studied groups of patients

Analysis of LMS %LS showed higher values in the group with more advanced atherosclerosis as compared with the groups where atherosclerosis was less severe (Figure 4).

There was a correlation found between minimal vessel diameter (MLD) measured using quantitative angiography and lumen area at the point of maximum stenosis (LAmin) (R=0.76 p=0.00002) (Figure 5). Among the studied patients, 21 (10.66%) had LAmin lower than 6.0 mm² and MLD lower than 2 mm; 4 subjects belonged to G2 and the others to G3.

Each patient in the studied population had LAmin of LMS analysed (Figure 6). In G1 the minimum area of LAmin was 9.03 mm² and the maximum 28.2 mm². In G2 12 patients (15.59%) had LAmin lower than 6 mm², in 29 pts. (37.66%) LAmin was within the range of 6.0 mm² to 9.0 mm² and in 32 pts. (46.75%) LAmin was higher than 9.0 mm² (range: 9.02-20.3 mm²). In G3 17 patients (80.95%) had LAmin lower than 6.0 mm² and the remaining 4 patients (19.05%) had LAmin values that ranged from 6.0 to 9.0 mm².

In the studied population the analysis of %LS of each patient was also conducted (Figure 7). It showed that none of the G1 patients had lumen area reduction of more than 50%. Only 10 (10.1%) G1 patients had lumen area reduction of 40-50%. Among the G2 patients 3 had %LS ≥50%, for 34 (44.2%) the value of this parameter was within the range of 40-50%, and in the remaining 40 (48.05%) patients %LS was less than 40%. All the G3 patients had LS% below 50%.

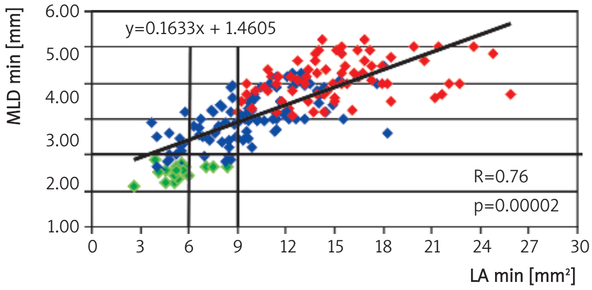

Figure 5. The correlation between minimal lumen area (LAmin) and minimal lumen diameter (MLD) of the vessel in the studied population

Detailed analysis revealed that in 3 (25%) cases of G2 patients with LMS LAmin of less than 6 mm², lumen stenosis of the vessel (%LS) was above 50%. In G3 were 4 (19.05%) patients with stents implanted, and LAmin was above 6 mm² and %LS stenosis was higher than 60%. All these 7 patients (3 G2 patients and 4 G3 patients) had a positive stress test and repeated anginal episodes, and G2 patients had already undergone successful PCI procedure targeting one of the LMS branches. These seven patients as well as 17 patients from G3 (with LAmin <6.0 mm² and %LS >50%) underwent the LMS stent implantation (n=24).

In the studied population a strong negative correlation (R=-0.77 p=0.033) between area lumen reduction and its minimal area was found (Figure 8).

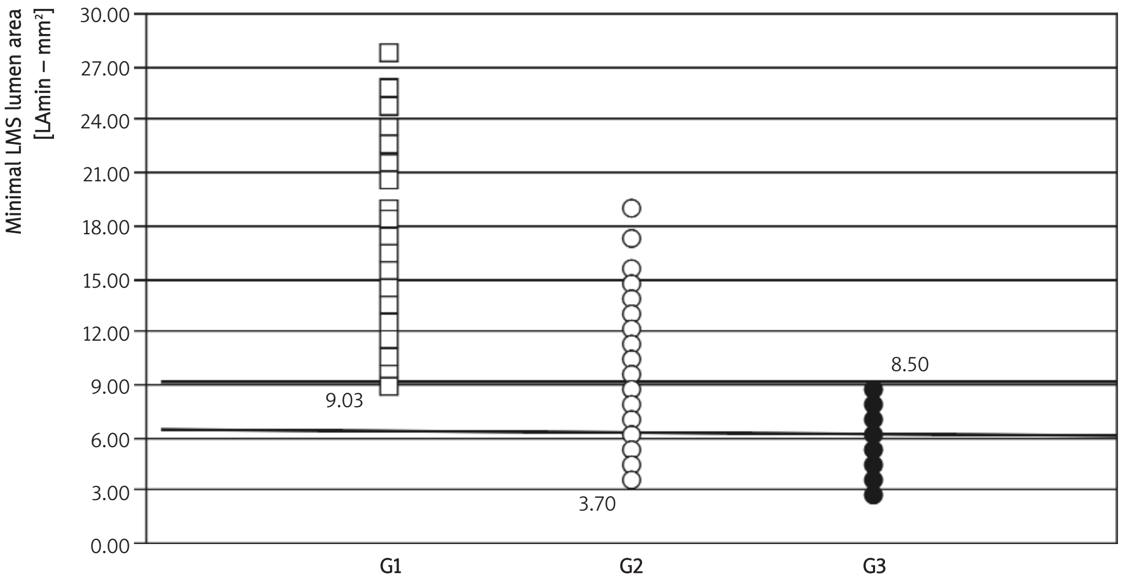

Figure 6. Comparison of lumen area at the point of stenosis in the studied groups

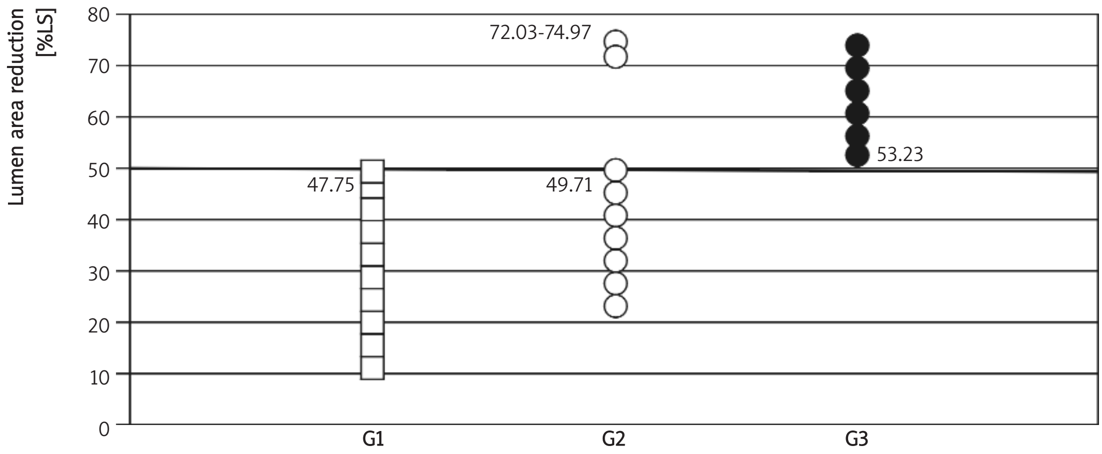

Figure 7. Lumen area reduction comparison in the studied groups

A very strong correlation (R=0.78 p=0.0003) between maximum residual atherosclerotic plaque and lumen area reduction was also noted (Figure 9). In the studied group 47 (23.86%) patients had PBmax above 60%; of these 21 were included in G3, and the remainder in G2. PBmax within the range of 50-60% was found only in 33 (16.75%) patients, belonging to G2 (42.85%).

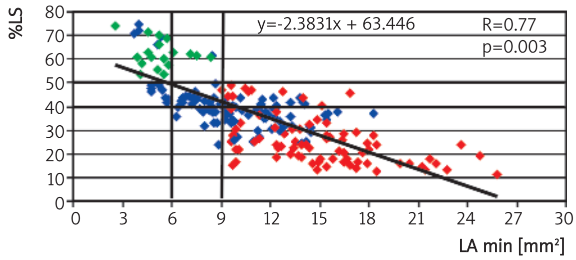

Figure 8. Lumen area reduction and minimal lumen area – comparison of the correlation in the studied population

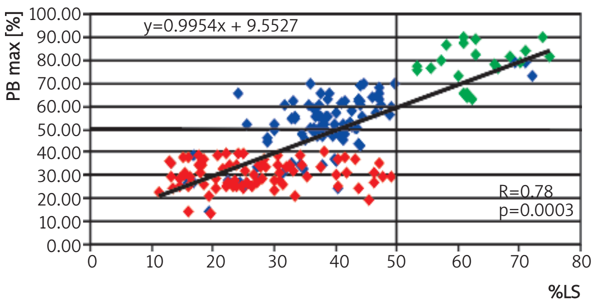

Figure 9. Lumen area reduction and maximum residual atherosclerotic plaque burden – comparison of the correlation in the studied population

All the PCI procedures were successful. The ECG stress tests performed in all the patients after LMS revascularisation (5-7 days) were negative. During the 12 month follow-up no deaths occurred. Restenosis was found in 19 G1 and G2 patients (11%) (LAD in 11 cases and LCX in 8 cases). Angiographic evaluation performed between 3 and 5 months after the original procedure showed that only 1 patient (4%) from G3 had restenosis. The other G3 patient with a positive ECG stress test had significant stenosis of the right coronary artery.

Discussion

Leung et al. [18] have found a correlation between the size of the intact coronary artery and myocardial area perfused by this vessel. The size of myocardial area supplied by LMS explains why the clinical consequences of LMS stenosis can be so serious. Our study confirmed that LMS was the biggest of all the coronary arteries. Similarly to other authors [9, 19, 22] we found that QSA underestimated the size of coronary vessels as compared with ICUS assessment. The reason is that QCA estimates the size of the lumen and not the real size of the vessel, which is the case for ICUS [9, 19, 20, 22]. The high correlation we demonstrated between MLD and LD suggests a significant percentage of arteries with less severe atherosclerotic lesions in our population [19, 22]. It is of importance that also the classic parameters of atherosclerotic plaque assessment (%DS and PBmax) show weaker correlation with more severe lesions [19, 23].

Qualification for interventional coronary artery disease treatment is relatively simple using QCA when the stenosis of the artery is significant (DS >70%) or insignificant (DS <45%). More problematic seems to be intermediate stenosis (%DS 45-70%). In such cases decisions are based on additional functional tests that classify these lesions as significant or not.

The special case is LMS stenosis where 50% diameter reduction is accepted to represent the threshold value for significant lesion. Therefore, intermediate stenosis of LMS should be recognized for DS within the range of 30-50%. The decision to undertake revascularization is not easy in such cases, especially if one remembers the possible consequences of in-stent restenosis. Unfortunately, there are no definite, widely accepted criteria helpful in the decision-making process [9, 21].

Introduction of ICUS has changed the way we look at atherogenesis in humans [19-23]. It is now well established that ICUS is the method best suited to verify the angiographic assessment and helps to make treatment decisions [9, 21].

Based on the representative group of patients we were able to collect detailed data on the development of atherosclerotic lesions in LMS. Ultrasound analysis of LMS enabled us to search for threshold parameters of significant LMS stenosis.

Our study shows that of all the angiographic parameters the most useful is MLD. With MLD ≤2.0 mm (lumen area of a little more than 3 mm^2) the likelihood of significant stenosis increases rapidly. In our study in only 2 (8%) cases with "intermediate stenosis" ICUS did not confirm a significant LMS lesion.

Nissen et al. [9] and Mintz [24] addressed the problem of defining the criteria for significant LMS obstruction based on ICUS examination. The first of the two authors [9] considered significant stenosis with the lumen area <9.0 mm^2 or stenosis with a reduction of the surface area of more than 50%. If the concepts of Nissen et al. were accepted, the demand for LMS revascularisation in our population would increase rapidly (more than double). However, clinical presentation and long term follow-up observations do not confirm that such an approach would be appropriate. On the other hand, Mintz [24] postulated that lumen area <6 mm^2 makes the stenosis significant. He proposed another parameter crucial for LMS lesion significance identification, i.e. %LS exceeding 50%. It verifies the LMS size and thus provides proper stenosis assessment, especially of "small vessels".

Our analysis suggests that lumen area of 6 mm^2 is the most appropriate threshold value for LMS LAmin, but the qualification for interventional treatment based on this sole parameter is at least risky. In the group of significant LMS stenosis in angiography (G3) in 17 (81%) patients the minimum area at the point of stenosis was lower than 6 mm^2, in the remaining 4 patients LAmin was within the range of 6-9 mm^2. In the group of "intermediate stenosis" (G2) as many as 12 (16%) patients had lumen area <6 mm^2 at the point of maximum stenosis and 29 (38%) patients had LAmin between 6.0 and 9.0 mm^2. These results suggest that assessment of minimal lumen area of LMS, especially if it is within the range of 6.0-9.0 mm^2, is not enough to establish the significance of an atherosclerotic lesion.

ICUS recordings analysis in our patients demonstrates the importance of the %LS parameter, thus confirming indirectly Mintz's [24] concepts. In group 3, consisting of patients with reliable indications for LMS revascularization (vessel diameter reduction >50% + clinical symptoms), in all cases %LS was above 50%. In group 2 with "intermediate stenosis" this was the case in only 3 (4%) patients. Additionally, all these 3 patients fulfilled the other Mintz criterion (LA min <6.0 mm^2). The 3 subjects of G2 underwent clinical assessment that confirmed angina through positive stress tests (with significant ST deviations in precordial leads) at the mean follow-up of 6 months after the PCI procedure (involving LAD or LCX changes). Control angiograms did not reveal either signs of in-stent restenosis or any new obstructive lesions. That is why we decided to implant LMS stents in these patients.

Finally, it is of note that PBmax, a parameter quite often used in clinical practice, is of no value to determine thresholds for LMS assessment. Even though a high value, i.e. 60%, is used, it does not protect the patient with a large lumen area of the vessel from being qualified for PCI. This is so despite the existence of a strong PBmax and %LS correlation. ECG stress tests results (negative in all patients after LMS PCI) might confirm that the decisions we made were correct. The relatively low restenosis rate (4%) after LMS stent implantation demonstrates the very high effectiveness of ICUS in the process of PCI optimization.

Conclusions

1. Our results suggest that LMS minimal lumen diameter ≤2 mm measured using quantitative angiography indicates a very high probability of significant stenosis.
2. Ultrasound data analysis suggests that apart from LMS lumen area <9 mm^2, a critical parameter to determine the significance of the lesion is lumen stenosis higher than 50%.

References

1. Bergelson BA, Tommaso CL. Left main coronary artery disease: assessment, diagnosis, and therapy. *Am Heart J* 1995; 129: 350-9.
2. Gil R, Gziut AI, Kubica J: Istotne zwężenie pnia lewej tętnicy wieńcowej – czy nadal jest wskazaniem do operacji kardiochirurgicznej? *Folia Cardiol* 2003; 10: 119-26.

3. Takaro T, Peduzzi P, Detre KM, et al. Survival in subset of patients with left main coronary artery disease. Veterans Administration Cooperative Study of surgery for coronary arterial occlusion disease. *Circulation* 1982; 66: 14-22.
4. Alfonso F, Macaya C, Goicolea J, et al. Intravascular ultrasound imaging of angiographically normal coronary segments in patient with coronary artery disease. *Am Heart J* 1994; 127: 536-44.
5. Aleksandrow W, Krupienicz A. Zwężenie głównego pnia lewej tętnicy wieńcowej. *Kardiol Pol* 1992; 36: 230-3.
6. Ge J, Erbel R. The left main coronary artery. In: Intravascular ultrasound. Erbel R, Roelandt JRTC, Ge J, Gorge G. (ed.). *Martin Dunitz*, London 1998, 125-30.
7. Boccalatte M, Mulvihill NT, Fajadet, et al. Unprotected left main coronary artery stenting in 2003. In: *EuroPCR* 2003: 155-72.
8. Abizaid AS, Mintz GS, Abizaid A, et al. One-year follow-up after intravascular ultrasound assessment of moderate left main coronary artery disease in patients with ambiguous angiograms. *J Am Coll Cardiol* 1999; 34: 707-15.
9. Nissen SE, Yock P. Intravascular ultrasound: novel pathophysiological insights and current clinical applications. *Circulation* 2001; 103: 604-16.
10. Gil R, Dudek D. Ultrasonografia wewnątrzwieńcowa – zastosowanie w kardiologii. *Forum Kardiologów* 1999; 3: 5-9.
11. Gerber TC, Erbel R, Gorge G, et al. Extent of atherosclerosis and remodeling of the left main coronary artery determined by intravascular ultrasound. *Am J Cardiol* 1994; 73: 666-71.
12. von Birgelen C, Airiian SG, Mintz GS, et al. Variations of remodeling in response to left main atherosclerosis assessed with intravascular ultrasound in vivo. *Am J Cardiol* 1997; 80: 1408-13.
13. Shiran A, Mintz GS, Leiboff B, et al. Serial volumetric intravascular ultrasound assessment of arterial remodeling in left main coronary artery disease. *Am J Cardiol* 1999; 3: 1427-32.
14. Johnston PW, Fort S, Cohen EA: Noncritical disease of the left main coronary artery: limitations of angiography and the role of intravascular ultrasound. *Can J Cardiol* 1999; 15: 297-302.
15. Hausmann D, Blessing E, Mugge A, et al. Angiographically undetected plaque in the left main coronary artery. Findings of intravascular ultrasound imaging. *Int J Card Imaging* 1997; 13: 293-9.
16. Di Mario C, Görge G, Peters R, et al. Clinical application and image interpretation in intracoronary ultrasound. Study Group on Intracoronary Imaging of the Working Group of Coronary Circulation and of the Subgroup on Intravascular Ultrasound of the Working Group of Echocardiography of the European Society of Cardiology. *Eur Heart J* 1998; 19: 207-29.
17. Scanlon PJ, Faxon DP, Audet AM, et al. ACC/AHA guidelines for coronary angiography: executive summary and recommendations. A report of the American College of Cardiology/American Heart Association. Task Force on Practice Guidelines (Committee on Coronary Angiography) developed in collaboration with the Society for Cardiac Angiography and Interventions. *Circulation* 1999; 99: 2345-57.
18. Leung WH, Stadius ML, Alderman EL: Determinants of normal coronary artery dimensions in humans. *Circulation* 1991; 84: 2294-306.
19. Kubica J. Zmiany miażdżycowe w tętnicach wieńcowych w angiografii i ultrasonografii wewnątrznaczyniowej. *Kardiol Pol* 1994; 41: 463-7.
20. Nissen SE. Coronary angiography and intravascular ultrasound. *Am J Cardiol* 2001; 87(Suppl.): 15A-20A.
21. Nissen SE. Application of intravascular ultrasound to characterize coronary artery disease and assess the progression or regression of atherosclerosis. *Am J Cardiol* 2002; 89 (Suppl.): 24B-31B.
22. Takahashi T, Honda Y, Russo RJ, et al. Intravascular ultrasound and quantitative coronary angiogarphy. *Cathet Cardiovasc Intarvent* 2002; 55: 118-28.
23. Hodgson JM, Reddy KG, Suneja R et al. Intracoronary ultrasound imaging: correlation of plaque morphology with angiography, clinical syndrome and procedural results in patients undergoing coronary angioplasty. *J Am Coll Cardiol* 1993; 21: 35-44.
24. Mintz GS. Intravascular ultrasound imaging: practical considerations. In: *Euro-PCR* 2002: 9-37.

Graniczne parametry zwężenia światła pnia głównego lewej tętnicy wieńcowej w oparciu o ultrasonografię wewnątrzwieńcową

Robert J. Gil[1], Aneta I. Gziut[1], Francesco Prati[2], Adam Witkowski[3], Jacek Kubica[4]

[1]Klinika Kardiologii Inwazyjnej, Centralny Szpital Kliniczny MSWiA, Warszawa

[2]European Imaging Laboratory, Rzym

[3]Instytut Kardiologii, Warszawa

[4]Klinika Kardiologii i Chorób Wewnętrznych Akademia Medyczna, Bydgoszcz

Streszczenie

Wstęp: Pień główny lewej tętnicy wieńcowej (LMS) zapewnia perfuzję lewej komory serca, a jego zwężenie wiąże się z groźnymi następstwami klinicznymi. Od prawidłowej oceny zwężenia LMS uzależniony jest rodzaj zastosowanego leczenia oraz odległe rokowanie. Do tej pory nie wyznaczono jednoznacznych kryteriów, pozwalających na właściwą ocenę zwężeń uznawanych w oparciu o angiografię ilościową (QCA) za problematyczne.

Cel: Próba wyznaczenia wartości granicznych parametrów ultrasonografii wewnątrzwieńcowej (ICUS), określających istotność zwężenia LMS.

Metody: Badaną populację stanowiło 197 pacjentów (średnia wieku 69,72±8,51) poddanych zabiegowi przezskórnej rewaskularyzacji (PCI) w lewej tętnicy wieńcowej. Grupę 1. (G1) stanowiło 99 pacjentów, u których redukcja średnicy (%DS) w LMS nie przekraczała 30%, natomiast grupę 2. (G2) – 77 pacjentów ze zwężeniem światła %DS 30–50%. Kolejnych 21 pacjentów ze zwężeniem %DS>50% w LMS zostało zakwalifikowanych do grupy 3. (G3). Analiza badania QCA obejmowała: średnicę LMS w miejscu największego zwężenia (MLD) oraz redukcję jego średnicy (%DS). Natomiast wśród analizowanych parametrów ICUS były: maksymalna wielkość blaszki (PBmax), minimalna średnica światła (LAmin) oraz redukcja światła (%LS) LMS. %LS wyznaczano wg wzoru: (LAmin/LAref.) x100%. Ponadto analizie poddano zależności pomiędzy analogicznymi parametrami uzyskanymi w badaniach QCA i ICUS.

Wyniki: W badanej populacji obie techniki diagnostyczne wykazały najbardziej zaawansowany stopień miażdżycy w G3. U wszystkich pacjentów z G3 oraz u 5 pacjentów z G2 wartość MLD nie przekraczała 2 mm. W grupie 1 wartości LAmin u wszystkich pacjentów przekraczały 9 mm^2, natomiast w G2 u 12 (15,5%) pacjentów były mniejsze od 6 mm^2, u 29 (37,66%) mieściły się w przedziale 6–9 mm^2, natomiast u pozostałych 36 (46,75%) przekraczały 9 mm2. W G3 u 17 (80,95%) wartości LAmin nie przekraczały 6 mm^2, natomiast u pozostałych 4 (19,05%) były nieznacznie większe. Stopień redukcji światła przekraczający 50% stwierdzono u wszystkich pacjentów z G3 oraz u 3 z G2 (u wszystkich 3 pacjentów z G2 wartości LAmin były mniejsze od 6 mm^2). U wszystkich pacjentów z G3 oraz u 3 z G2 z LAmin <6 mm^2 oraz %LS>50% stwierdzono występowanie dolegliwości stenokardialnych oraz dodatni wynik testu wysiłkowego. Wszyscy ci chorzy (n=24) zostali poddani zabiegowi implantacji stentu do LMS.

Wnioski:

1. Z naszych badań wynika, że minimalna średnica LMS ≤2 mm uzyskana w angiografii ilościowej oznacza bardzo duże prawdopodobieństwo istotności zwężenia w takim naczyniu.
2. Analiza danych ultrasonograficznych dowodzi, że obok wielkości światła (<9 mm^2) LMS decydującym parametrem dla określenia istotności jego zwężenia jest redukcja światła tego naczynia, przekraczająca 50%.

Słowa kluczowe: pień główny lewej tętnicy wieńcowej, ultrasonografia wewnątrznaczyniowa, choroba wieńcowa, stentowanie wieńcowe

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Adres do korespondencji:

prof. dr hab. n. med. Robert J. Gil, Klinika Kardiologii Inwazyjnej, Centralny Szpital Kliniczny MSWiA, ul. Wołoska 137, 02-507 Warszawa, tel.: +48 22 508 11 00, faks: +48 22 508 11 77, e-mail: kardiologia.inwazyjna@cskmswia.pl