

The Short-Term Effect of Stent Size and Number on Left Ventricular Systolic Function Improvement After Elective Percutaneous Coronary Intervention

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Background. The effect of stent size and number on left ventricular systolic function improvement after percutaneous coronary intervention (PCI) using drug eluting stent is not clear enough.

Aim. To study short-term effect of stent size and number on left ventricular systolic function improvement after elective PCI.

Material and methods. The study included 150 adult patients with electively stented left anterior descending artery lesion with drug-eluting stent. Patients were examined before PCI and 1 and 3 months after PCI using speckle tracking echocardiography.

Results. Before revascularization, mean left ventricular ejection fraction was $51.2\% \pm 5.7$, mean global longitudinal peak systolic strain (GLPSS) $-9.29 \pm 0.94\%$. One month after PCI, mean GLPSS increased significantly to $-14.05 \pm 1.72\%$ ($p < 0.001$), 3 months after PCI, even more significant improvement in the GLPSS up to $-18.61 \pm 3.02\%$ ($p < 0.001$) was recorded. After 3 months, 53 patients (35.3%) showed recovery to normal GLPSS. The predictors of non-improvement of GLPSS after 3 months were: diabetes mellitus ($p = 0.007$), smoking ($p = 0.01$), dyslipidemia ($p = 0.001$), stent length ($p = 0.001$), and a number of stents ($p = 0.04$). There was strong negative correlation between stent length and improvement of the GLPSS in 1 month ($p = 0.007$) and in 3 months ($p < 0.001$). Also there was strong negative correlation between number of stents and improvement in 1 month ($p = 0.002$) and in 3 months ($p = 0.004$), but the correlation between stent diameter and improvement of the GLPSS was significant neither in 1 month nor in 3 months ($p = 0.924$ and $p = 0.435$, respectively).

Conclusion. Number and length of stents implanted were predictors to improvement of systolic function, while stent diameter doesn't affect left ventricular recovery.

Keywords: stent length, stent diameter, elective PCI, speckle tracking echocardiography.

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Introduction

Left ventricular systolic function is a major predictor of long-term survival in patients with coronary artery disease. Evaluation of regional and global sub-clinical left ventricular (LV) systolic dysfunction could be a good strategy to identify myocardial regions with impaired coronary artery flow and reduced myocardial perfusion [1].

Improving the myocardial perfusion and LV systolic function are among the objectives of a successful percutaneous coronary intervention (PCI). Over the past several years, there has been a profound evolution in the techniques used for PCI. It is clear that the availability of coronary stents and platelet glycoprotein IIb/IIIa receptor inhibitors has dramatically changed the early and late clinical outcomes associated with PCI [2].

The management of long coronary lesions by PCI has become increasingly important because of the rising incidence of long or complex lesions in aging populations. Management of long lesions with single long stent is a preferred strategy of PCI. Long lesions have been associated with adverse outcomes in PCI with implantation bare metal stents. However, the exact impact of lesion length on the short- and long-term clinical outcomes of drug-eluting stent (DES) implantations is not clear yet [3].

How do stent size and number affect recovery of left ventricular function after percutaneous coronary intervention using DES? There is no clear data till now in this relation.

Aim of study. To evaluate short-term effect of stent size (length and diameter) and number on left ventricular systolic function improvement after elective left anterior descending artery (LAD) stenting with DES using speckle tracking echocardiography.

Material and methods

Study design. It was a single center, prospective observational study that was conducted at cardiology department at Benha University hospital during the period from November 2017 till October 2018.

Inclusion criteria. Adult patients of both gender with electively stented LAD lesion with DES were en-

rolled in the study. Patients were evaluated pre PCI then follow up at 1 month and 3 months using speckle tracking echocardiography.

Exclusion criteria. Patients with bundle branch block, previous PCI, previous coronary artery bypass graft, rhythm other than sinus, rheumatic heart disease, prosthetic valve, complicated or unsuccessful PCI procedure, patients with significant degenerative changes, patients with previous STEMI, and dropped patients from follow up were excluded from the study.

The study was approved by the local Ethical Committee and all patients signed informed consent.

History taking was done with emphases on age, gender, and risk factors (diabetes mellitus, hypertension, family history of premature coronary artery disease). Laboratory parameters included lipid profile, fasting and 2-hour post prandial blood glucose.

Transthoracic echocardiography. Echocardiography was performed by machine (Vivid 7) with multi-frequency transducer. All images were recorded digitally to allow off-line quantitative analysis and assessment of inter-laboratory reproducibility of measurements. Each measurement was averaged over three consecutive beats during sinus rhythm.

By conventional echocardiography, two-dimensional echocardiograms were obtained in accordance with the American Society of Echocardiography guidelines. Global LV function was assessed by measuring LV end-diastolic and end-systolic volumes from two-dimensional apical views, by measuring LV ejection fraction (LVEF) by means of the modified biplane Simpson's method [4].

Speckle tracking echocardiography. Three consecutive end-expiratory cardiac cycles at frame rates >70 frames/sec harmonic imaging were acquired in the apical four-chamber, apical two-chamber, and the long axis views. The 2D-speckle tracking echocardiography analysis was performed offline on grayscale images of the LV obtained in these views. The endocardial border was manually traced in end-systole, and the software automatically tracked the myocardial region of interest. Once the regions of interest were optimized, the software generates au-

tomatically strain curves for different myocardial segments. From the apical four-chamber view, longitudinal strain was assessed through basal, mid, apical inferior septal segments; basal, mid, and apical antero-lateral wall segments. From the apical two-chamber view, longitudinal strain was assessed through basal, mid, apical, inferior segments; basal, mid, and apical anterior wall segments. From the apical long axis view, longitudinal strain was assessed through basal, mid, apical inferior lateral segments; basal, mid, and apical anterior septal segments. Global longitudinal peak systolic strain (GLPSS) has been calculated as the mean strain of all 17 segments. As a guide, a peak GLPSS in the range of -20% could be expected in a healthy person, and the lower the absolute value of strain is below this value, the more likely it is to be abnormal [4].

Coronary angiography. Coronary angiography was done for all the patients according to the Judkins technique. All images were evaluated by an experienced operator, significant coronary artery disease was defined as >70% lumen diameter stenosis. The following data was obtained:

- Site of stent implantation within LAD. The first diagonal branch serves as the boundary between the proximal and mid portion of the LAD. Thus, the portion of the artery prior to the origin of the first diagonal is known as the proximal LAD, while the segment just below the first diagonal branch is the mid LAD. The distal segment of the LAD is the terminal third of the artery.
- Length, diameter and number of stents.
- TIMI flow after stent deployment.

Statistical methods. Data management and statistical analysis were done using SPSS vs.25. (IBM, Armonk, New York, United states). Numerical data was summarized as means and standard deviations. Categorical data was summarized as numbers and percentages. Speckle tracking echocardiography and tissue synchronization imaging of different segments were compared at different timepoints using ANOVA. Post hoc analysis was done and all post hoc were Bonferroni adjusted for multiple comparisons. Correlation analysis was done between stent length,

stent diameter and percent change in speckle tracking echocardiography and tissue synchronization imaging at 1 month and 3 months using Pearson's correlation. Correlation coefficient r ranges from -1 to +1: -1 indicates strong negative correlation; +1 – strong positive correlation; 0 – no correlation. Multivariate linear regression analyses were done for prediction of GLPSS at 3 months. Regression coefficient (B) with 95% confidence intervals were calculated for predictors. All p values were two sided; p values less than 0.05 were considered significant.

Results

This is a single center, prospective study that was conducted at cardiology department at Benha University hospital during the period from October 2017 till June 2018. Of the 265 patients included only 150 patients fulfilled the inclusion criteria (11 patients had diseased vessels other than LAD, 23 patients had previous revascularization, 44 patients needed revascularization in right coronary artery or left circumflex artery, 15 patients had rhythm other than sinus rhythm, and 22 dropped patients).

Of the 150 patients of the study, 100 patients (66.7%) were males, with mean age 53 ± 9 , 65 patients (43.3%) were diabetics, 76 patients (50.7%) were hypertensive, 80 patients (53.3%) were smokers, while 15 patients (10%) were ex-smokers, 89 patients (59.3%) had dyslipidemia and 53 patients (35.3%) had family history of premature coronary artery disease.

Before revascularization, the mean left ventricular end systolic volume was 43.2 ± 12.8 ml, the mean left ventricular end diastolic volume was 88.3 ± 21.6 ml, and mean LVEF was $51.2 \pm 5.7\%$. Mean GLPSS was $-9.29 \pm 0.94\%$.

All patients had drug eluting stents, 132 patients (88%) had single stent while 18 patients (12%) had two stents. As regard site of stent, 15 patients (10%) had distal LAD stenting, 100 patients (66.7%) had mid LAD stenting while 35 patients (23.3%) had proximal LAD stenting, and mean stent length (mm) was 29.9 ± 10 with mean stent diameter (mm) 3.16 ± 0.4 .

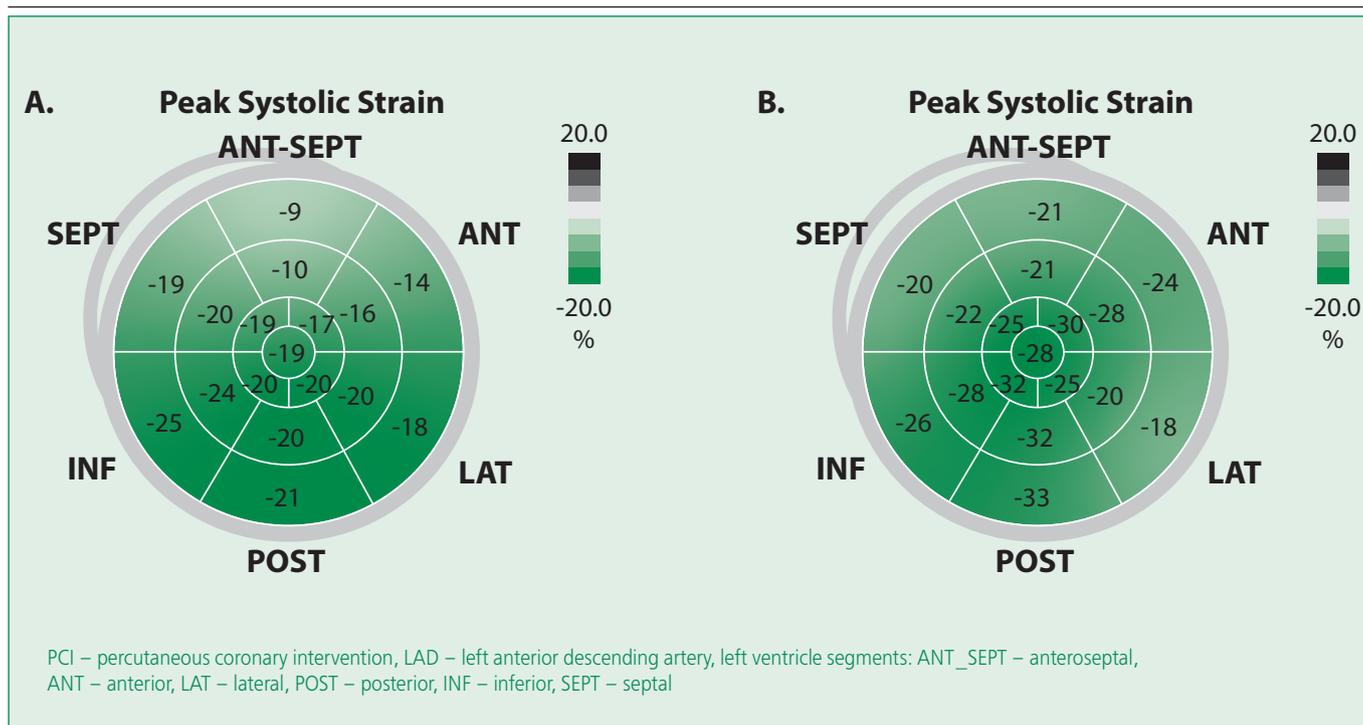


Figure 1. Speckle tracking echocardiography before PCI on the LAD (A) and 3 months after PCI (B) in 50-year-old smoking male patient with a lesion of 1.1.0 according to A. Medina classification

One month after PCI, mean GLPSS improved significantly from $-9.29 \pm 0.94\%$ to $-14.05 \pm 1.72\%$ ($p < 0.001$), 3 months after PCI there was a further improvement in the indicator, which has become $-18.61 \pm 3.02\%$ ($p < 0.001$). After 3 months, 53 patients (35.3%) showed recovery to normal GLPSS (fig. 1).

By multivariate linear regression analysis the predictors of non-improvement of GLPSS after 3 months were determined; diabetes mellitus ($p = 0.007$), smoking ($p = 0.01$), dyslipidemia ($p = 0.001$) and stent length ($p = 0.001$), number of stents ($p = 0.04$).

There was strong negative correlation between stent length and improvement of the GLPSS at 1 month ($r = 0.218$, $p = 0.007$) and at 3 months ($r = 0.359$, $p < 0.001$). Also there was strong negative correlation between number of stents and improvement at 1 month ($r = 0.247$, $p = 0.002$) and at 3 months ($r = 0.232$, $p = 0.004$) but the correlation between stent diameter and improvement of the GLPSS was significant neither at 1 month nor at 3 months ($r = 0.008$, $p = 0.924$ and $r = 0.064$, $p = 0.435$ respectively).

Discussion

Why does size matter? De E. Benedetti and P. Urban [5] found that stent size (length and diameter) ensures the best immediate result and the lowest possible long-term complication rate. It is known that larger stents induce more trauma to vessels and therefore more intimal hyperplasia, more edge dissections and more coronary ruptures and so more incidence of complications.

For bare metal stents it is clear that the longer the stent and smaller the diameter, the more risk of stent thrombosis and restenosis but for DES, it is not clear yet.

For detection of left ventricular systolic recovery we used speckle tracking echocardiography, which has recently emerged as a quantitative technique to accurately estimate myocardial function. By the analysis of the motion of speckles in the two-dimensional ultrasonic image, this technique allows a non-Doppler angle-independent objective analysis of myocardial deformation, with the possibility to quantify thickening, shortening and rotation dynamics of cardiac function [6].

The present study included 150 patients of both genders at Benha University hospital during the period from November 2017 till October 2018. Patients were evaluated pre PCI, 1 month and 3 months after PCI by conventional echo and speckle tracking echocardiography.

In the present study there was significant improvement of GLPSS which was observed at 1 month and at 3 months ($p < 0.001$), 35.3% of the included patients recovered to normal value

There was significant negative correlation between stent length and number and improvement of GLPSS, but there wasn't significant correlation regarding stent diameter.

The optimal time to trace recovery of the LV systolic function after elective stenting was not clear throughout literature which could be explained by the modality used to detect the recovery (conventional echo vs deformation imaging). G. Magdy et al. [7] found that there wasn't significant improvement in GLPSS within 24 hour post procedure, but after 3 months, there was significant improvement ($p = 0.001$). G. Holly et al. [8] studied the changes in various echocardiographic parameters in 40 patients with chronic stable angina undergoing PCI. They found that GLPSS significantly increased at both 48 h and 6 weeks after PCI ($p < 0.001$) which means significant improvement of systolic function. They concluded that strain imaging can detect the early improvement of the LV systolic function in patients with chronic stable angina undergoing PCI even as early as 48 h after PCI.

Stent length was an important predictive factor of LV recovery to normal value after elective PCI; it was associated also with increase in major adverse cardiac events (MACE). So, Sandeep et al. [9], who studied the effect of stent length on clinical outcome in patients with coronary artery disease, found that total number of MACE was significantly higher in patients with stent lengths more than 32 mm compared with patients with stent lengths 29-32 mm and

24-28 mm ($p = 0.045$). Stent length has been major predictor of adverse events after PCI.

This was discordant with M. Agirbasli et al. [10], who found that the stent length did not correlate with the LVEF change ($p = 0.369$), which can be explained by the fact that the stents were relatively short, on average 17.4 ± 6 mm. While, patients who received LAD stent with diameter > 3 mm had significantly higher LVEF change after PCI compared to those who received a stent ≤ 3 mm in diameter ($p = 0.041$).

Most of the studies that included patients with implanted DES, focused on studying the effect of limited intimal hyperplasia on the long-term outcomes, including in different groups of patients, in particular diabetics. In the scientific literature there are limited data about short-term PCI outcomes evaluated by speckle tracking echocardiography, which was our aim in the present study.

Conclusion

After elective PCI of LAD artery using DES, number of stents implanted and length of stents were predictors of improvement of LV systolic function: the shorter the stent length and the fewer the number of stent implanted, the higher chance improvement of LV systolic function, while stent diameter does not affect LV recovery.

Limitations. The present study was single center one, with short-term follow up; all patients had focal LAD lesions and none of them had complex PCI or complicated procedure; all patients had pre PCI normal LVEF according to conventional echo and none of them had impaired systolic function, so we focused on LV function recovery by deformation image.

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