

Nonsignificant difference in Segmental Left Ventricular Dysfunction between triple 50% and a single 75% Stenosis of the same Coronary Artery

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Summary

We have been stressing the importance and the influence of a single 50% coronary artery stenosis on segmental left ventricular wall (LVW) systolic and diastolic dysfunctions. In this study the influence of multiple 50% stenosis of the same coronary artery on segmental LVW systolic and diastolic functions were analyzed. Total 288 coronary arteries were enrolled. There were significant difference of segmental LVW systolic and diastolic functions between normal and single 50% coronary artery stenosis (CAS), single and double 50% CAS, and double and triple 50% CAS. But there was no significant difference between triple 50% stenosis and single 75% stenosis.

Introduction

We have been proving and stressing the importance and the influence of a single 50% CAS on segmental LVW systolic and diastolic dysfunctions clinically and experimentally [Fig-1,2,3]. The results have been presented in the Congresses. In this study we analyzed the influence of multiple 50% stenosis of the same coronary artery (CA) on segmental LVW systolic and diastolic functions and compared it to the segmental LVW function of single 75% CAS.

All procedures were performed in accordance with the Declaration of Helsinki of the World Medical Association. The consent of Clinical's ethical committee was obtained.

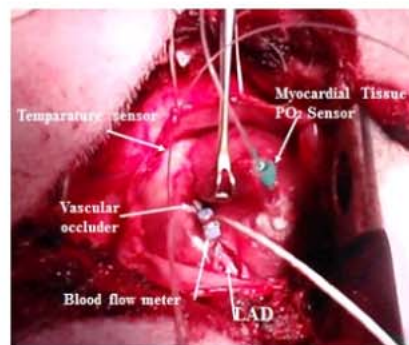


Fig-1: The picture of animal experiment. LAD and LCX of pig's heart were made single 50% stenosis by external occluders confirmed by CAG multidirectionally and coronary blood flow and myocardial tissue PO_2 were measured. This figure was presented in 9th ICCAD 2011, Venice, Italy.

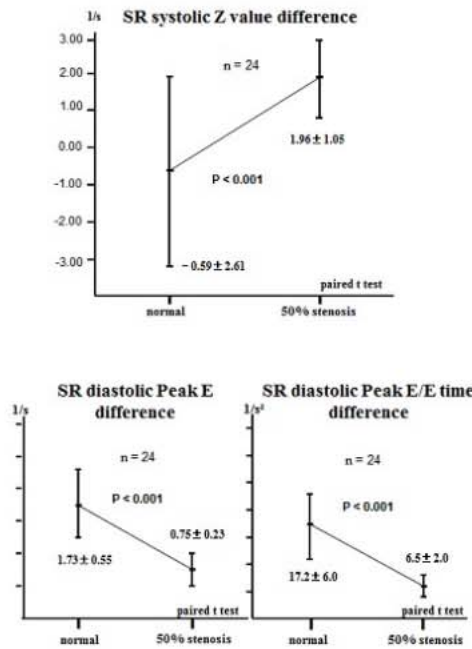


Fig-2 Influence of single coronary artery stenosis on systolic segmental function “Z” and diastolic segmental function “Peak E”, “Peak E/E time” in human patients. “Peak E/E time” seems more Sweden and EUROECHO & other imaging Modalities Congress 2011, Budapest, Hungary.

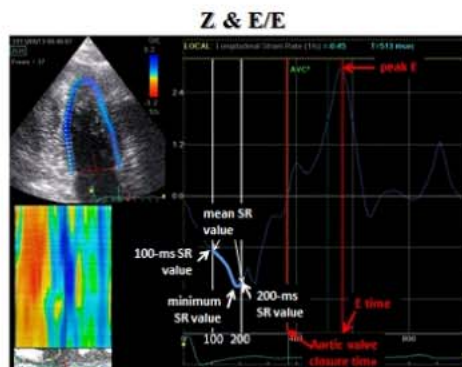


Fig-3 Values on strain rate profile to use “Z” and “E/E” functions. By using these values and functions, this complicated strain rate profile can be read and applied to clinical use.

Method

Eighty-nine patients (pts) with 89 normal coronary arteries and 112 patients with a single and multiple 50% CAS (69pts x1, 52pts x2, 34pts x3) and 44 pts with 44 CAs of a single 75% CAS were employed.

We used echocardiographical systems to analyze the data. The systems we used were consisted of : Vivid 7 Dimension digital ultrasound system, Version 7.0.3. (General Electric Healthcare, Inc., U.S.A.), 1.5/4.0 MHz active-matrix array (AMA) probe and EchoPAC PC Version 108.1.4..

The functions we used to estimate the segmental LVW systolic and diastolic functions by Strain Rate profile of echocardiography were:

Systolic function⁽¹⁾ :

$$Z = 4.91 + 1.02 \times (100\text{-ms SR value}) + 1.23 \times (200\text{-ms SR value}) - 0.46 \times (\text{minimum SR value between } 100\text{-ms and } 200\text{-ms SR value}) + 4.83 \times (\text{mean SR value between } 100\text{-ms and } 200\text{-ms SR values}).$$

Diastolic function :

$$E/E = \text{peak E/E time } \%/ \text{sec}^2 \text{ (E time: time from aortic valve closure to peak E of SR profile).}$$

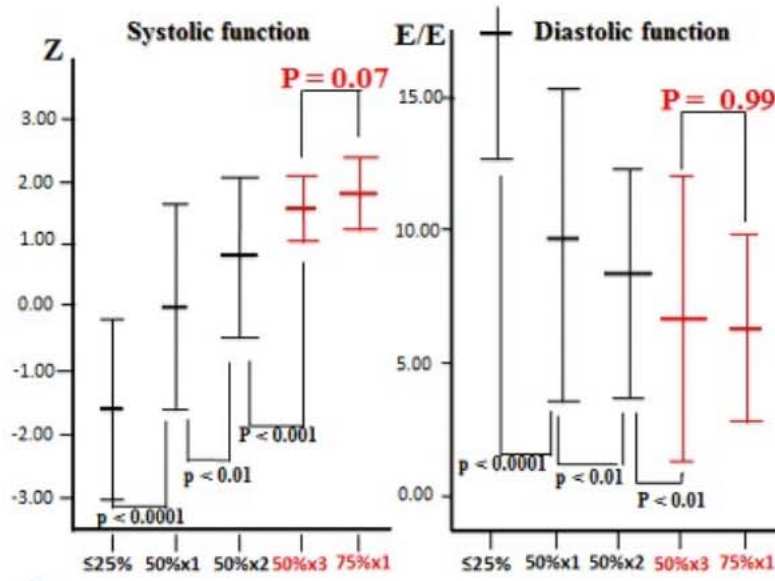


Fig-4 The results of the table make the graphs to see clearly the importance of 50% coronary artery stenosis at a glance. 50% stenosis should be regarded as significant stenosis.

Results

The Z values were : normal = -1.70 ± 1.41 , $50\% \times 1 = -0.02 \pm 1.60$, $50\% \times 2 = 0.78 \pm 1.26$, $50\% \times 3 = 1.55 \pm 0.47$ and $75\% \times 1 = 1.81 \pm 0.62$. There were significant differences in segmental LVW Z values between normal, $50\% \times 1$, $50\% \times 2$ and $75\% \times 1$ ($p < 0.0001$). No significant difference was observed between $50\% \times 3$ and $75\% \times 1$ ($p = 0.07$) [Fig-5,6].

Table-1 In animal experiment, segmental systolic function “Z” rose and diastolic function “Peak E” and “Peak E/E time” fell in single 50% coronary artery stenosis. When “Z” rises up, the segmental systolic function is reduced. “Peak E” and “Peak E/E” fall, the segmental diastolic function is reduced. These animal experimental data were presented in 9th ICCAD 2011, Vence, Italy.

Segmental Systolic and Diastolic Left Ventricular Wall Function

| Coronary Artery Stenosis | | | | |
|--------------------------|------------|------------|------------|------------|
| Stenosis | ≤25% | 50% | 75% | 90%≤ |
| Num. of Vessels | 94 vessels | 91 vessels | 26 vessels | 43 vessels |
| Systolic Function | | | | |
| Z value | -1.7 | -0.38 | 1.49 | 3.07 |
| ± | ±1.41 | ±1.86 | ±0.75 | ±1.61 |
| p | | p < 0.001 | p < 0.001 | p < 0.001 |
| Diastolic Function | | | | |
| Peak E | 1.75 | 1.34 | 1.13 | 0.21 |
| ± | ±0.46 | ±0.61 | ±0.34 | ±0.48 |
| p | | p < 0.05 | p < 0.001 | p < 0.001 |
| Peak E/E time | 17.23 | 10.11 | 7.28 | 6.67 |
| ± | ±5.12 | ±4.57 | ±2.26 | ±1.86 |
| p | | p < 0.01 | p < 0.001 | p < 0.001 |

The E/E values were : normal = 18.16 ± 5.13 , $50\% \times 1 = 10.39 \pm 6.33$, $50\% \times 2 = 8.94 \pm 4.63$, $50\% \times 3 = 7.39 \pm 5.62$ and $75\% \times 1 = 7.09 \pm 3.64$. There were significant differences in segmental LVW E/E values between normal, $50\% \times 1$, $50\% \times 2$ and $75\% \times 1$ ($p < 0.0001$). No significant difference was observed between $50\% \times 3$ and $75\% \times 1$ ($p = 0.99$) [Fig-5,6].

Table-2 The results of this study are shown in the table of this slide. Both of systolic and diastolic segmental functions are deteriorated from a single 50% coronary artery stenosis significantly. They are deteriorating significantly as the number of lesions of 50% stenosis increases. But no significant difference is observed between lesions of triple 50% stenosis and single 75% stenosis.

[Results]

| Stenosis | 25%≥ | 50% × 1 | 50% × 2 | 50% × 3 | 75% × 1 |
|---------------------|------------|---------|-----------|---------|----------|
| Z: average | - 1.70 | - 0.02 | 0.78 | 1.55 | 1.81 |
| ± SD | ± 1.41 | ± 1.60 | ± 1.26 | ± 0.47 | ± 0.62 |
| t-test: p values | p < 0.0001 | | | | |
| | | | p < 0.01 | | |
| | | | p < 0.001 | | |
| | | | | | p = 0.07 |
| E/E: average | 18.36 | 10.39 | 8.94 | 7.09 | 7.08 |
| ± SD | ± 5.13 | ± 6.33 | ± 4.63 | ± 5.62 | ± 3.64 |
| t-test: p values | p < 0.0001 | | | | |
| | | | p < 0.01 | | |
| | | | P < 0.01 | | |
| | | | | | P = 0.99 |

Discussion

Reduction of coronary artery blood flow starts from 50% stenosis, though flow reserve starts reducing from 75%≤ stenosis⁽²⁾. Most ignore this phenomenon, and none has yet studied the influence of coronary flow reduction by 50% CAS on segmental LVW function. This study showed reduced coronary blood flow by 50% CAS caused segmental LVW systolic and diastolic dysfunction, even though it hold normal blood flow reserve as it was reported.

We should consider the long-term (5~10 years) prognosis of segmental LVW function which has been influenced by 50% coronary artery stenosis

Conclusion

The results of this study indicate that triple lesions of so-called nonsignificant 50% coronary artery stenosis influences systolic and diastolic dysfunction of segmental left ventricular wall the same as a single significant 75% coronary artery stenosis.

The results also remind us the invasive coronary artery intervention should be done to regain normal left ventricular segmental wall function quickly and positively, but not only to relieve chest pain.

References

- 1) Ri-ichiro Kakihara, MD, Takahiko Suzuki, MD; Follow-up of Patients after Coronary Intervention by Non-stress Echocardiography — Detection of ≥75% Coronary Artery Stenosis with Strain Rate Function, *Therapeutic Research*, 30: 1971-1981, 2009
- 2) Marcelo Di Carli, MD, Johannes Czemin, MD, Carl K. Hoh, MD, Victor H. Gerbaudo, PhD, Richard C. Brunken, MD, Sung-Chen Huang, DSc, Michael E. Phelps, PhD, Heinrich R. Schelbert, MD; Relation Among Stenosis Severity, Myocardial Blood Flow, and Flow Reserve in Patients With Coronary Artery Disease, *Circulation*, 91: 1944-1951, 1995