Intérêt de l'étude de la fonction ventriculaire gauche par le 2D Strain dans les syndromes coronariens aigus

Interest of the study of left ventricular function by 2D Strain in acute coronary syndrome

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RÉSUMÉ

Introduction : Le 2D Strain est une nouvelle technique écho-cardiographique permettant l'étude de la déformation myocardique basée sur un suivi des marqueurs acoustiques de la paroi. Le but de notre travail était de valider l'apport de cette technique dans la détection de territoire d'ischémie et dans la prédiction de l'axe coronaire coupable et du statut tronculaire par comparaison aux données de l'exploration coronarographique et aussi l'étude de la corrélation de ce paramètre avec la FEVG et le WMSI.

Méthodes : Il s'agit d'une étude de cohorte à visée analytique incluant 173 patients consécutifs ayant présenté un syndrome coronarien aigu au cours de la période entre Janvier 2015 et Octobre 2016. Tous les patients ont fait l'objet d'une échocardiographie avec étude du 2D Strain à la phase aigue et une coronarographie. Les fiches ont été répertoriées sur une base de données SPSS.

Résultats : L'âge moyen des patients était de 62±10 ans. Le Sex ratio était de 6H/1F. 78% étaient tabagiques, 46% étaient diabétiques, 44% étaient hypertendus. La FEVG moyenne était 50±10%, le SLG moyen était -14±4%. On a objectivé que le SLG était plus altéré lorsque l'atteinte intéresse l'IVA avec une moyenne de -13,9 % versus -17,2 % et -17,8% respectivement pour la CX et La CD et il était plus altéré aussi lorsque l'atteinte est tri ou bitronculaire avec une moyenne de -13,7% versus -15,8% chez les monotronculaires. L'étude statistique a objectivé une corrélation significative entre le SLG et l'âge (p= 0 ,007);le type de SCA (p=0,017); la FEVG (p<0,001);le WMSI (p<0,001). on a objectivé aussi une corrélation significative entre le SLG et la sévérité de l'atteinte coronaire (p<0,001) ; le statut tronculaire (p<0,001) et surtout une corrélation avec l'axe coronaire coupable (p<0,001). En Effet le Strain longitudinal a permis de prédire l'axe coronaire coupable dans 92% des cas dans notre étude.

Conclusion : Le Strain Longitudinal 2D représente un excellent paramètre qui permet une détection fiable d'une altération de la fonction systolique du VG dans les cardiopathies ischémiques et trouve surtout son utilité dans la prédiction de l'axe coronaire coupable et du statut tronculaire.

Mots-clés

SLG : Strain longtidunal global ; FEVG : fraction d'éjection, Simpson Biplan ; WMSI : Wall Motion Score Index ; SCA : Syndrome coronarien aigu ; IVA : Interventriculaire antérieure ; CX : circonflexe ; CD : Coronaire Droite

SUMMARY

Background : The 2D Strain is a new echo-cardiographic technique allowing the study of the myocardial deformation based on a follow-up of the acoustic markers of the LV wall. The aim of our study was to validate the contribution of this technique in the detection of the ischemia and in the prediction of the culprit coronary axis and the number of vessels affected and also we analyzed the correlation of this parameter with the Left Ventricle Ejection Fraction (LVEF) and the Wall Motion Score Index (WMSI).

Methods : This is a prospective study included 173 consecutive patients admitted for acute coronary syndrome (ACS) during the period between January 2015 and October 2016. All the patients had echocardiography with analysis of function by 2DStrain and a coronary angiography .The data have been listed on an SPSS database.

Results : The mean LVEF was 50 +/- 10%, the mean global longitudinal peak systolic strain (GLPSS) was -14 +/- 4% and the mean WMSI was 1.68 +/- 0.4. The study showed that GLPSS was more impaired when Left Anterior Descending (LAD) is affected with an average of -13.9% versus -17.2% and -17.8% for Left Circumflex (LCx) and Right Coronary Artery (RCA) respectively and was more impaired also when the patients have two or three-vessel lesions with an average of -13.7% versus -15.8% in the single-vessel lesions. The statistical study showed a significant correlation between GLPSS and the age (p = 0.007); the type of ACS (p =0.017); the LVEF (p <0.001)and the WMSI(p <0.001).The study showed a significant correlation between GLPSS and the severity of coronary artery disease (p <0.001) and especially a significant correlation with the culprit coronary axis (p <0.001).In Fact ; the longitudinal strain has been predicted the culprit coronary axis in 92% of the cases in our study.

Conclusion : The 2D Longitudinal Strain represents an excellent parameter which allows a reliable detection of an alteration in the systolic function of the LV in ischemic heart disease and it's very useful to predict the culprit coronary axis and the number of vessels affected.

Key-words

LVEF : Left ventricle ejection fraction ; WMSI : Wall Motion Score Index ; ACS : Acute Coronary Syndrome ; GLPSS : global longitudinal peak systolic strain ; LAD : Left Anterior Descending ; LCx : Left Circumflex ; RCA : Right Coronary Artery

INTRODUCTION

The 2D Strain is a new echocardiographic technique allowing the study of the myocardial deformation based on a follow-up of the acoustic markers of the Left Ventricle (LV) wall and an evaluation of the cardiac motion in its three components: radial, longitudinal and circumferential. The aim of our study is to validate the contribution of this technique in the detection of the ischemia and in the prediction of the culprit coronary axis and the number of vessels affected and also we analyze the correlation of this parameter with the Left Ventricle Ejection Fraction (LVEF) and the Index (WMSI).

METHODS

This cohort analysis study included 173 consecutive patients who were admitted for acute coronary syndrome (ACS) during the period between January 2015 and December 2016. All the patients had echocardiography with analysis of function by 2DStrain and a coronary angiography. The examinations were executed by a single machine and a single operator. The echogenicity of the subjects is generally considered satisfactory. The data have been listed on an SPSS database.

All patients included had a sinus rhythm in the electrocardiogram , have undergone echocardiography with 2D Strain study in the acute phase with a delay not exceeding 10 days between the date of admission and the Strain study. All patients have undergone coronary angiography during their hospitalization.

We didn't include the patients with atrial fibrillation, the patients whom the time between the 2D Strain study and the date of hospitalization exceeded the acute phase, the patients with a very bad acoustic window and the patients whom weren't explored by coronary angiography.

Echocardiography and the 2D Strain Study:

The echocardiography examinations were performed by a VividE9 Device (General Electric Medical Systems, Horten, Norway) equipped with a M5S matrix probe. The examinations were transferred to a computer for post-image analysis with Echopac software (General Electric Medical Systems).

The patient was comfortably seated on an examination table, bare-chested, positioned in the left lateral decubitus, slightly elevated trunk, spread left arm with possibility of mobilization (supine, right lateral decubitus), with calm breathing. Electrocardiographic recording was essential. The operator was positioned in the right of the patient. He noted the clinical context of the patient (BP, Auscultation) and paraclinical (ECG, RX, biology). All exams were performed by a single operator. We eliminated post extra-systolic cycles. We identified the end of diastole and the end of systole with the mitral valve movements and the cavity size in addition to the ECG. The environment was calm and dark with controlled temperature.

The apical incidences had been used to analyze the longitudinal deformation of the left ventricle. Starting from a two-dimensional black and white echocardiography incidence, we performed a rapid contouring of the endocardium by positioning, in general, less than ten points in the endocardial-cavity interface at the end of systole.

The software had then applied, from this contouring, a follow-up of the endocardium by interpolation to each image of the recorded cardiac cycle.

Three apical incidences are needed for the longitudinal strain study (4, 2 and 3 cavities) at the same heart rate. The automate suggests a region of interest with an adjustable and repositionable thickness by the operator. This region of interest corresponds to the wall thickness to be analyzed. The operator ensures the contouring and optimal tracking of the movements of each segment of the LV wall by the software during the complete cardiac cycle and he validates it if he considers it correct. If he does not consider it optimal, he can reposition the number of points required, this is the point by point method. (Figure 1).

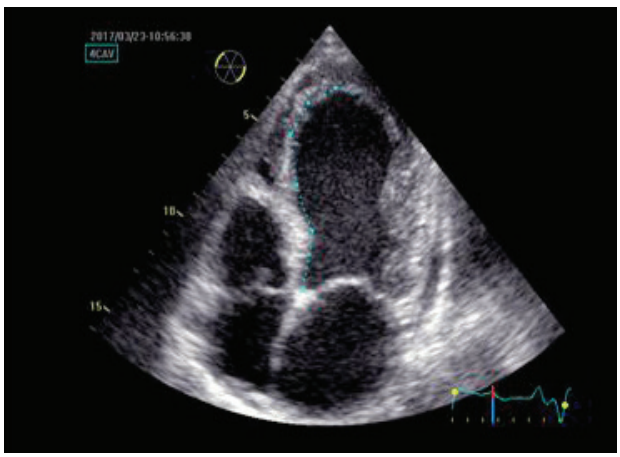

Figure 1: Incomplete Contouring of the Endocardium at the end of systole from a 4-Cavity Apical Incidence on Echopac Software

It is also possible to obtain a faster representation of the systolic longitudinal deformation peaks of the 17 ventricular segments in target form, by positioning 3 points in each of the 3 apical incidences conventional (4, 2 and 3 cavities) at the same heart rate, without performing a complete contouring; this is the AFI (Automatic Function Imaging) method. [1]

When the myocardial follow-up is qualified as optimal and approved by the operator, the software is launched for an analysis of the segmental and global deformations which are represented in the form of colorized curves. [2, 3]

Mean normal values of Global Longitudinal peak Systolic Strain (GLPSS) range from -18% to -26% [4]; when the overall longitudinal strain is pathological, the pathological segments appear on the "bull's eye" representation. [5] (Figure 2)

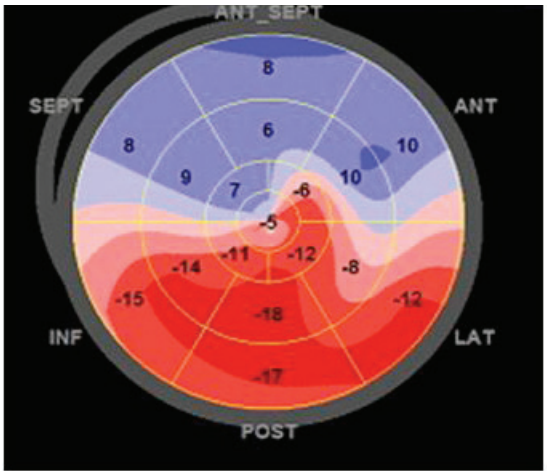

Figure 2: Representation of a pathological longitudinal strain - «Bull's Eye"

Coronary angiography

All the patients included in the study had coronary angiography. We noted for each patient the number of vessels affected; the culprit coronary axis and the severity of coronary artery disease. We considered as a severe coronary artery disease: the Left main artery lesion, the proximal Left anterior descending (LAD) artery lesion and the three vessels disease. All the patients had a significant coronary artery disease (>50% Left main; >70% others).

The LAD irrigates the 17th apical segment, the apical anterior segment, the apical antero-septal segment, the anterior wall and the antero-septal wall. The LCx (left Circumflex) irrigates the apicolateral segment, the anterolateral wall and the inferolateral wall. The RCA (Right coronary artery) irrigates the apical inferior segment, the inferoseptal wall and the inferior wall [6]. This distribution is not constant and varies according to left / right dominance and anatomical atypia.

Statistic Analysis

The sheets were indexed on an SPSS database, the quantitative parameters were expressed as mean, and the qualitative parameters were expressed as a percentage. The Pearson correlation was used to study the correlation of the value of SLG with the different parameters. More the correlation coefficient (r) is closer to the extreme values -1 and 1, the stronger is the linear correlation between the variables. We found a strong correlation between two parameters when the coefficient (r) in absolute value exceeded the value of 0.5.

The degree of significance is determined by the value of (p); we considered the difference between two variables as statistically significant when $p < 0.05$.

RESULTS

Descriptive Study

The mean age of patients was 62±10 years with a male predominance 5M/1F. 78% were smokers, 46% were diabetic, and 44% had high blood pressure. The electrocardiogram at admission included ST segment elevation in 51.5% of cases, ST segment depression in 12.3% of cases, LBBB in 2% of cases, RBBB in 1.5 % of cases, necrosis Q waves in 2% of cases and negative T waves in 45.4%. 57% of patients presented an STEMI; 43% an NSTEMI. The anterior territory was the most frequently affected (51.5%), followed by the inferior territory (35%) and then the lateral territory (6.8%). ECG was normal in 6.7% of cases. The mean LVEF was 50 ± 10%, the mean global longitudinal strain (GLS) was -14 ± 4%, and the mean WMSI was 1.68 ± 0.4. The mean LV end-diastolic diameter (LVED) is 51±7 mm and the mean LV end-systolic diameter (LVES) is 34±8 mm.

72% of patients had severe coronary artery disease.39% of patients have monotroncular coronary artery disease (CAD), 28% have bitroncular CAD and 33% have tritroncular CAD. The Culprit axis was the LAD in 55% of the cases; the Left Circumflex (LCx) axis in 20% of cases and the Right Coronary artery (RCA) axis in 25% of cases.

Analytic study

The study showed that GLS is more impaired when the LAD is affected with an average of -13.9% versus -17.2% and -17.8% for LCx and RCA respectively and is more impaired also when the patient has two or three-vessel lesions with an average of -13.7% versus -15.8% for the single-vessel lesions. The GLS is more reduced when the coronary artery disease is severe with an average of -13, 4% versus -17,5% for not-severe lesions. The study also revealed that a cut-off of GLS (absolute value) less than or equal to 14% predicts a LV systolic dysfunction (< or = 40%) with a sensitivity of 93% and specificity of 81%. (Figure 3)

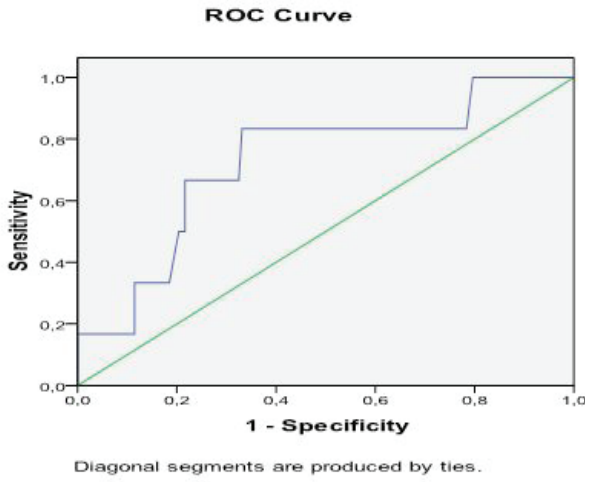

Figure 3: ROC curve GLPSS/LVEF Area under the curve = 0,78

We also evaluated the correlation between GLS and severity of coronary artery disease .We concluded that a cut-off of GLS (absolute value) less than or equal to 13.7% can predict severe coronary disease with a sensitivity of 78% and Specificity of 89%. (Figure 4)

The statistical study showed a significant correlation between GLS and the age (p = 0.007); the type of Acute coronary syndrome (p =0.017); the LVEF (p <0.001) (Figure 5), the WMSI (p <0.001) (Figure 6) and the severity of coronary artery disease (p <0.001).

We found also a significant correlation between GLS and the prediction of culprit coronary axis (p <0.001). The longitudinal strain has predicted the culprit coronary axis in 92% of the cases in our study (Figure 7). We also compared the probable number of vessels affected according to the GLS data with that determined by coronary angiography.

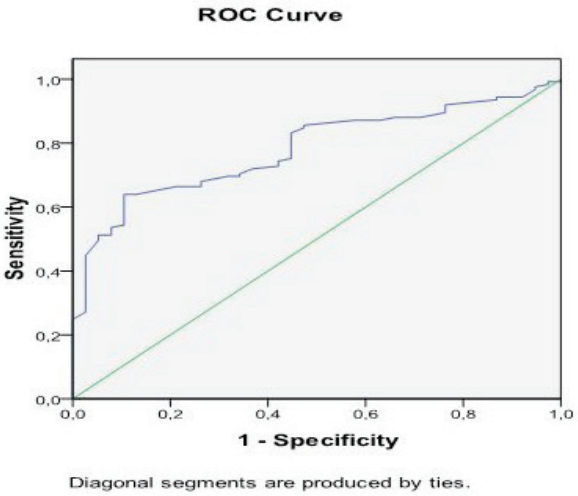

Figure 4: ROC Curve GLPSS/ Severity of CAD Area under the curve = 0,82

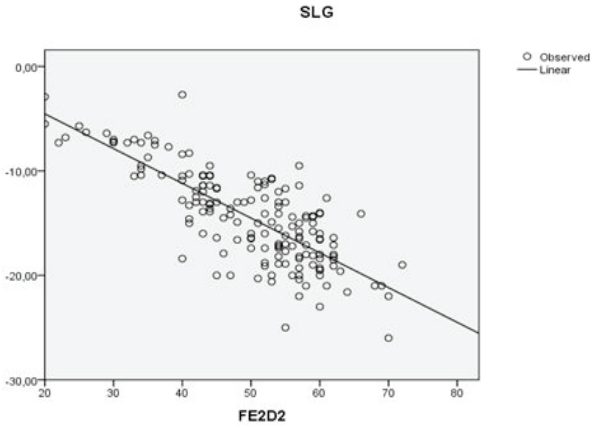

Figure 5: Correlation GLPSS/LVEF(r= -0,78 ; p<0,001)

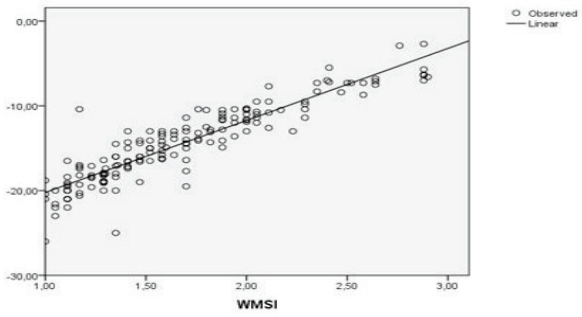

Figure 6 : Correlation GLPSS/WMSI

r= 0,91 ; p<0,001

Figure 6: Correlation GLPSS/WMSI r= 0,91 ; p<0,001

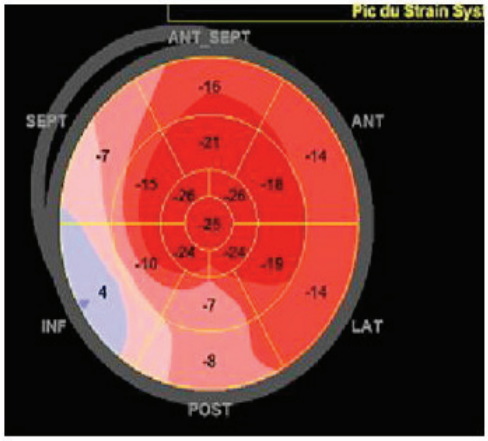

Figure 7: Example from our study illustrating the GLS / culprit coronary axis correlation: Male 58 years old - inferior STEMI admitted H4 – impairment of longitudinal strain of the infero-septal, inferior and infero-lateral walls. Coronary angiography: Occlusion of right coronary artery (2nd segment).

We revealed a significant correlation (p <0.001). The longitudinal strain has predicted the patient's number of vessels affected at the acute phase of coronary syndrome in 80% of the cases in our study.

DISCUSSION

Since 2004, a "new" technique of deformation analysis has appeared called "Speckle Tracking Echocardiography" (STE) or «Two-dimensional Strain « (2D Strain). [7] This technique allows to "dissect" the cardiac motion in its radial, longitudinal and circumferential components. The normal value of longitudinal strain is around -20%. The 2D Strain has been applied in several pathologies: hypertrophic cardiomyopathy, mitral regurgitation, dilated cardiomyopathy, toxic heart disease, pediatric cardiology and especially ischemic heart disease. [8]. This technique allows a more objective analysis of the LV deformation segment-by-segment which is largely superior to the visual evaluation of wall abnormalities operative-dependent. [9, 10] The different studies showed a strong correlation between the GLS and the LVEF Biplane Simpson: R. Ryczek et al [11] have shown that the assessment of the longitudinal deformation by the GLS is likely to be better than the standard echocardiographic assessment. Their study had included 44 patients admitted for NSTEMI who's the mean LVEF was 43.1 ± 12.7% but the mean GLS value was impaired -13.8 ± 5.6%. The authors found a good correlation between these two parameters (r = - 0.59, p <0.001).

Ben Younes.N et al [12] have studied also the longitudinal strain in 507 patients who had routine echocardiography. They revealed a significant correlation between the GLS and the LVEF (r =-0.53, p <0.001). The study also found that a cut-off of GLS (absolute value) less than or equal to 14% predicts a LV systolic dysfunction (< or =40%) with a sensitivity of 95% and specificity of 86%.

Vrettos et al [13] also demonstrated a significant correlation between GLS and the severity of coronary artery disease evaluated by the SYNTAX score (r= -0.75; p <0.001) . The Study showed that a cut-off (absolute value) of GLS less than or equal to 14% can predict severe coronary disease with a sensitivity of 68% and Specificity of 89%.

The prediction of the culprit coronary axis at the acute phase of coronary syndrome represents one of the major challenges of the 2D Strain study.

Thibault Caspar et al [14] worked on this subject. They included 58 patients admitted for acute coronary syndrome without elevation of the ST segment.

They showed a significant correlation between the suspected culprit coronary axis according to Strain longitudinal study and that determined by coronary angiography (r = -0.84 p <0.0001).

Noah Liel-Cohen et al [15] included also 105 patients with Known coronary artery disease and admitted for an acute coronary syndrome. They compared the Longitudinal Strain and coronary arteriography. They found a significant correlation between the territory and the extent of infarction assessed by longitudinal Strain and the culprit coronary axis angiographically (r = -0.84, p <0.0001).

Limits of our study:

Like any study, we have been faced with a few limitations as:

- the need for optimal image quality: The necessity to acquire an image with a clearly visible endocardial limit for the entire cardiac cycle. Patients with very bad acoustic windows were not included.
- the existence of reverberation artifacts: These artifacts are related to the trapping of ultrasound between two reflective surfaces between which they bounce. At each rebound, a small echo is released towards the probe and forms an image. The delay between two echoes leads the machine to place the image to a greater and greater depth.

- the dependency of the frame rate :The frame rate is defined by the number of frames per second (FPS) and is expressed in Hertz or FPS.

-rapid atrial fibrillation: The irregularity of the cycles does not allow a correct analysis of LV deformation with a difficulty of obtaining the different sections 4; 3 and 2 cavities at the same heart rate. To overcome this limitation, we did not include patients with atrial fibrillation.

-The need for early completion of the acute phase examination of coronary syndromes

After an acute ischemic episode, there may be viable myocardial zones around the necrotic zone but not contracting the so-called stun phenomenon. These abnormalities are transient and the stunned myocardium recovers a normal contractility a few days after the coronary syndrome from where the possibility to distort the results if the examination is carried out late after recovery of the dumbfounded territories. We did not include patients whose delay between the date of admission and the study of 2D Strain exceeded 10 days.

CONCLUSION

The 2D Longitudinal Strain represents an excellent parameter which allows a reliable detection of an alteration in the systolic function of the LV in ischemic heart disease and it's very useful in prediction of the culprit coronary axis and the number of vessels affected at the acute phase of coronary syndrome.

Conflict of interest: *none declared*

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