MEDICAL EDUCATION

Evaluation of the SYNTAX score by residents in clinical cardiology

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ABSTRACT

Background
The SYNTAX score (SS) is a useful tool for selecting patients with left main or three-vessel coronary artery disease eligible for percutaneous coronary interventions. The score has moderate inter-observer reproducibility among members of the original study. There is not sufficient evidence about the evaluation of the SS by non-interventional cardiologists.

Objectives
The aim of the study was to evaluate whether residents in cardiology can perform an adequate evaluation of the SS and to detect possible biases in its evaluation.

Methods
Coronary angiographies with evidence of main left coronary artery disease and/or three-vessel disease were retrospectively selected. A resident in cardiology (RC) calculated the total SS in order to compare it with the score calculated by an interventional cardiologist (IC). Data were analyzed using the kappa coefficient (deciles and tertiles), Lin's concordance correlation coefficient and the Bland-Altman plot method.

Results
Ninety three coronary angiographies were analyzed. Mean SS calculated by the IC and the RC were 28.58 (SD 10.0) and 30.44 (SD 10.7), respectively. Mean difference was 1.85 (SD 7.01). The kappa coefficient was 0.57 (0.464-0.678) for deciles and 0.60 for tertiles (0.48-0.72). Lin's coefficient was 0.75 (0.65 to 0.83). The Bland-Altman analysis detected that the RC had a trend towards underestimating high scores calculated by the IC.

Conclusions
This study demonstrates a moderate to good inter-observer reproducibility between a RC and an IC. This level of agreement is acceptable to calculate the score, as previously published. A trend to underestimate high SS was detected in the RC.

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Abbreviations >				
APCI	Percutaneous coronary intervention		SD	Standard deviation
IC	Interventional cardiologist		SS	SYNTAX score
CABGS	Coronary artery bypass graft surgery		RC	Resident in cardiology

BACKGROUND

Coronary artery bypass graft surgery (CABGS) as the revascularization strategy in patients with multivessel coronary artery disease is currently under debate. (1) The advent and development of percutaneous coronary interventions (PCI) in multivessel coronary artery disease has demonstrated that this is a feasible method with outcomes comparable to those of CABGS. (2-4)

The SYNTAX trial used a specially designed score to evaluate the angiographic complexity of coronary artery lesions. The conclusion of this study was that PCI was not inferior to CABGS in a certain group of patients. (5) Therefore, the SYNTAXscore(SS) is presented as a useful tool for selecting patients with left main or three-vessel coronary artery disease eligible for PCI.

The score has moderate inter-observer reproducibility among the core lab members of the

original study. (6) The assessment of the SS has not been sufficiently evaluated by non-interventional cardiologists raising doubts about the applicability of the score by cardiologists in general. If an in-training cardiologist is capable of making an adequate assessment of the SS, he/she may use the score in their daily practice toinitiallydirect the patient's revascularization strategy.

The goal of this study is to evaluate whether residents in cardiology can perform an adequate evaluation of the SS and to detect possible biases.

METHODS
Coronary angiography selection
Data from consecutive diagnostic coronary angiographies from patients with left main coronary artery disease and/or three-vessel disease were prospectively collected. None of the patients had history of previous revascularization. The angiographies had been performed in 2009 at theInstituto Cardiovascular de Buenos Aires.

Observers
A voluntary resident in cardiology (RC) in the second year of the residency program at the institution completed the tutorial and self evaluation available at the web site www.syntaxscore.com before starting to use the SS calculator. (7) The RC then calculated the total SS of all the included angiographies using the automated scoring algorithm available at the same web site. These results were then compared with those calculated by an interventional cardiologist (IC) from the institution. The observers were blinded to the identity of the patient and the treatment used. Both observers calculated the total SS in an independent fashion using forms placed in different orders. They did not take part of the statistical analysis.

Sample calculation and statistical analysis
We estimated that 90 angiographies had sufficient power to demonstrate inter-observer reproducibility (8) with alpha and beta error < 1% to detect a correlation coefficient of 0.5 or higher between both observers.

The level of inter-observeragreement was evaluated using Cohen's kappa coefficient stratified by decilesand tertiles, the latter corresponding to the prognostic SS strata adjusted for continuous linear variables (linear weighted kappa). Table 1 shows the qualitative interpretation of the kappa index beyond chance. Lin's concordance correlation coefficient was used to evaluate agreement of quantitative analysis. The results were analyzed and presented in graphs with the classical Bland-Altman plot and its modification according to the reference method to look for any possible bias.

Continuous variables are expressed as mean ± standard deviation. Statistical analysis was performed using SPSS 18.0.0 statistical package for Windows (SPSS Inc, Chicago, Ill, USA) and MedCalc11.4.1.0 for Windows (MedCalc Software, Mariakerke, Belgium).

RESULTS
Ninety three coronary angiographies were analyzed. The results stratified in deciles and tertiles are shown in the contingency tables (Tables 2 and 3). Mean SS estimated by the IC and CR was 28.58 (SD 10.0) and 30.44 (SD 10.7), respectively. Precision between

observers was calculated as the mean difference between observer estimations (1.85) and accuracy as its SD (7.01).

The kappa coefficient was 0.57 (95% CI 0.46-0.67) for deciles and 0.60 for tertiles (95% CI 0.48-0.72). Lin's concordance correlation coefficient was0.75 (95% CI 0.65-0.83), Pearson's correlation coefficient (r) was 0.77 and bias correction factor (c-b) was 0.98.

The Bland-Altman plot (Figure 1) shows that most of the observations are within the 95% CI and does not suggest the presence of systematic errors. Six observations fall out of the 95% CI (6.45%) and there are 10 exact observations (10.7%). Using the IC SS as reference value (Figure 2), The RC had a trend towards underestimating high scores (> 35) calculated by the IC.

DISCUSSION
This study demonstrated a moderate to good inter-observer reproducibility between a RC and an IC. The level of agreement is considered acceptable

Table 1. Qualitative interpretation of kappa index*

kappa value	Level of agreement
0	None
0.01-0.20	Poor
0.21-0.40	Slight
0.41-0.60	Moderate
0.61-0.80	Good
0.81-0.99	Optimal

* Sackett D, et al. Clinical epidemiology: A basic science for clinical medicine. 2nd ed. Boston: Brown and Co; 1991.

Table 2. Contingency tables stratified by deciles

		RC					Total
		10-19	20-29	30-39	40-49	>59	
IC	10-19	15	7	1	0	0	23
	20-29	7	11	9	2	0	29
	30-39	0	3	18	10	0	31
	40-49	0	0	4	5	0	9
	> 50	0	0	0	0	1	1
Total		22	21	32	17	1	93

Table 3. Contingency tables stratified by tertiles

		RC			Total
		≤ 22	23-32	≥ 33	
IC	≤ 22	17	7	2	26
	23-32	6	10	13	29
	≥ 33	0	3	35	38
Total		23	20	50	93

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according to the one achieved among members of an interventional cardiology laboratory. However, a certain difficulty was detected in the RC to estimate complex anatomies.

It is necessary to use methods to detect a certain subgroup of patients with extensive coronary artery disease that might benefit from PCI. The complexity of coronary artery anatomy appreciated by the SS demonstrated that patients with scores ≤ 32 had similar results to those of CABGS after one year follow up in terms of major cardiovascular events. The predictive value of the SS has been validated in multiple clinical trials. (9-13) In addition, it has been compared with the clinical SYNTAX score (14, 15) and with the fractional flow reserve-guided SS. (16) Therefore, the SS should be included at the moment of deciding the revascularization strategy in patients with multivessel disease, (17) a decision also taken by clinical cardiologists.

The SS is a score based on coronary angiography and there is no evidence of its estimation outside the

Fig. 1. Classic Bland-Altman plot.

Fig. 2. Modified Bland-Altman plot according to the reference method.

catheterization laboratory; thus, the interpretation of the score by non-interventional cardiologists might be controversial. An in-training cardiologist (RC) was capable of calculating a SS similar to the one estimated by an IC. Therefore, we believe that this is a way of demostrating the feasibility of calculating the SS in non-specific environments.

The available literature has focused the reproducibility of the SS on members of an interventional cardiology laboratory. After publication of the SYNTAX trial, the official group published theassessmentof inter-observer and intra-observer variabilityin Eurointervention. In this case, the SS was evaluated by two angiographic core laboratory technicians with a moderate level of agreement. The SYNTAX score was subsequently reassessed by a team of ICs with moderate intra-observer reproducibility. (18) Several recently published studies have estimated good inter-observer reproducibility among interventional cardiologists and core lab technicians. (19-21) Therefore, moderate inter-observer reproducibility is acceptable for most investigators, particularly for those of the SYNTAX group.

Visual evaluation of angiographic lesions depends, to a certain extent, on inter-observer variability, (22-24), which is corrected in part by using quantitative methods. (25) We may similarly assert that the SS has a moderate to good inter-observer agreement (kappa coefficient: 0.4 to 0.8, including 95% CI) for risk stratification and for identifying the different prognostic strata. Quantitative analysis using Lin's concordance correlation coefficient coincides with the rest of the results. Mean SS was comparable to that of the official validation study, demonstrating that the complexity of coronary artery lesions was similar.

Since visual estimation of coronary artery angiography by an IC is more precise and accurate; this "gold standard" can be compared to the difference between observers using the Bland-Altman plot method. (26) This method detected that the RC had a trend towards underestimating score values > 35 calculated by the IC, probably due to the fact that the RC has not been trained to evaluate multiple or very complex lesions that are present in patients with high SS. Total SS increases with the number of lesions and with the characteristics of each lesion: calcification, tortuosity, length, involvement of other branches and chronic nature of all lesions. Probably, a RC may not be sufficiently trained to detect these characteristics and thus underestimates high SS. Therefore, considering this observation, score values evaluated by the RC near the highest cutoff value may belong to the highest SS stratum.

It should be emphasized that it was necessary topreviously train the RC with the tutorials available at the SYNTAX web site. We consider this is an important step to apply these conclusions and also to train RC in the evaluation of coronary angiographies in general.
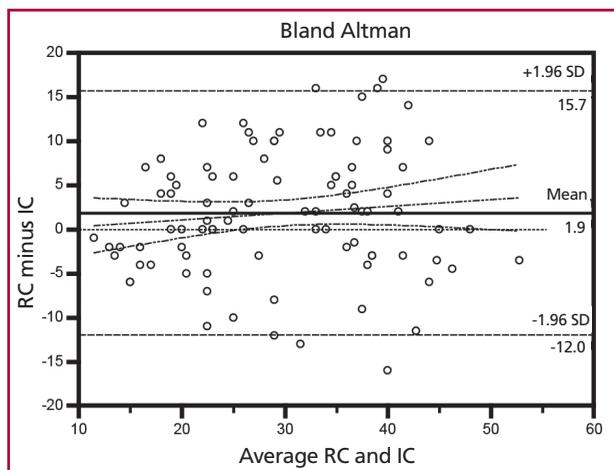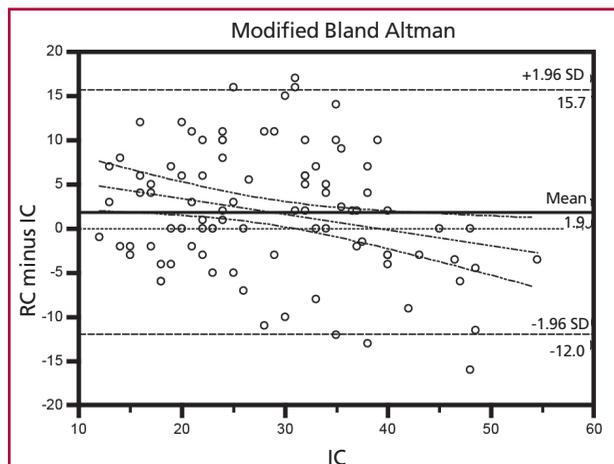
Study Limitations

Inter-observer variability is frequently evaluated by the kappa coefficient in different scenarios. However, it has some limitations. The coefficient estimates the level of agreement over the chance level and values greater than 0.8 are considered as excellent inter-observerreproducibility. A moderate inter-observer agreement (kappa 0.4 to 0.8) may not be accepted at the moment of defining one strategy or the other. The SS, as other prognostic models, is proposed as a complementary yet not determinant tool.

It may not be appropriate to apply conclusions about the observation of an IC and a RC in a particular center to the rest of the institutions. The presence of inter-observer agreement may be influenced by the availability of a homogeneous and sophisticated system of image acquisition and visualization, thus increasing precision in both observers. The fact that residents in cardiology receiving training in high-volume interventional cardiology centers may have better experience in visualizing coronary angiographies should also be considered.

Observations made by members of the same center may generate bias. Therefore, only diagnostic studies evaluated in an independent fashion and performed two years ago were used in order to reduce bias, without identifying the patient and using forms placed in different orders.

Only the total score, and not the different components of the SS, was analyzed, limiting the analysis ofpoints with greater agreement or disagreement in coronary angiography.

CONCLUSIONS

This study demonstrates a moderate to good inter-observer reproducibility between a RC and an IC. The level of inter-observer agreement is similar to the one published by the SYNTAX group and is considered acceptable. Visual analysis detected a certain difficulty of the RC in the estimation of complex anatomies.

RESUMEN

Relación entre la circunferencia del cuello y el diagnóstico de hipertensión arterial en el Registro Nacional de Hipertensión Arterial (RENATA)

Introducción
El puntaje SYNTAX (PS) se presenta como una herramienta útil para la selección de pacientes con enfermedad del tronco y/o de tres vasos pasibles de revascularización mediante angioplastia. Existe una moderada reproducibilidad interobservador entre miembros del estudio original. No se dispone de evidencia suficiente sobre la evaluación del PS por miembros ajenos a un laboratorio de cardiología intervencionista.

Objetivos
Evaluar si residentes de cardiología pueden realizar una valoración adecuada del PS y detectar posibles sesgos en ella.

Material y métodos
Se seleccionaron en forma retrospectiva cinecoronariografías que evidenciaban enfermedad del tronco y/o de tres vasos. Un residente de cardiología (RC) calculó el PS total para compararlo con lo calculado por un cardiólogo intervencionista (CI). Se analizaron los datos mediante el coeficiente kappa (deciles y terciles), el coeficiente de concordancia de Lin y gráficamente a través del método de Bland-Altman.

Resultados
Se analizaron 93 cinecoronariografías. Las medias del PS del CI y del RC resultaron de 28,58 (DE 10,0) y de 30,44 (DE 10,7), respectivamente. La diferencia de las medias fue de 1,85 (DE 7,01). El coeficiente kappa resultó de 0,57 (0,464-0,678) para deciles y de 0,60 para terciles (0,48-0,72). El coeficiente de Lin fue de 0,75 (0,65 a 0,83). El análisis de Bland-Altman detecta una tendencia del RC a infraestimar puntajes altos del CI.

Conclusiones
El presente trabajo demuestra una moderada a buena reproducibilidad interobservador entre un RC y un CI. Este nivel de acuerdo es tolerable para su cálculo según lo publicado. Se detectó una tendencia del RC a infraestimar PS altos.

Palabras clave >   Angioplastia - Revascularización miocárdica - Enfermedad coronaria - Angiografía

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