Kiosk 5R-FA-06

Evaluation of Deep Learning Estimation of Whole Heart Anatomy FBom Automated Cardiovascular Magnetic Resonance Short- and Long-axis Analyses in UK Biobank

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Background: Standard methods of heart chamber volume estimation in cardiovascular magnetic resonance (CMR) utilize simple geometric formulae based on a limited number of slices. Deep Learning (DL) methods can provide accurate 3D anatomy from sparse slices [1]. We aimed to evaluate whether an automated deep learning neural network prediction of 3D anatomy of all four chambers would show stronger associations with cardiovascular risk factors and disease than standard volume estimation methods in the UK Biobank.

Methods: After quality control, we compared 4776 participants with recorded cardiovascular disease, and 5795 cases with no recorded disease as a reference group. Short and long axis cine images were analysed automatically using Circle cvi42 version 5.11 release 1505 (Circle Imaging, Calgary, Canada). The software used a previously validated [2] deep learning convolutional neural network and returned LV endocardial, LV epicardial, and RV endocardial contours for short axis as well as three-chamber, two-chamber and four-chamber long axis views. For the standard method, chamber volume for the right and left ventricles and right and left atria were obtained from the Circle reports automatically generated from the machine learning contours, with no additional manual correction. The network predictions were given by a label completion network [3] adapted to predict 3D segmentations at ~1mm isotropic resolution from standard CMR short and long axis segmentation. Multivariate regression analyses were used to quantify the effect of age, sex, height, body mass index, systolic blood pressure and disease on chamber volume index. Strengths of association were compared between standard volume estimation and network 3D volume estimation.

Results: Table 1 reports study population characteristics, with statistical difference between CVD and no CVD samples for all factors. The left and right ventricular volumes obtained by the network were all statistically different from the standard slice summation method, particularly for the atria in which single plane and biplane formulae are inaccurate [1]. Statistical differences between CVD and no-CVD groups were generally preserved, except for left atrial ESV index and right atrial EDV index (Table 2). Multivariate regression analyses across all cases resulted in stronger associations (-log p) with risk and disease factors for all volume estimates (Figure 1).

Conclusion: Neural network reconstructions of whole heart had stronger associations with cardiovascular disease and risk factors than standard volume estimation methods in an automatic processing pipeline.

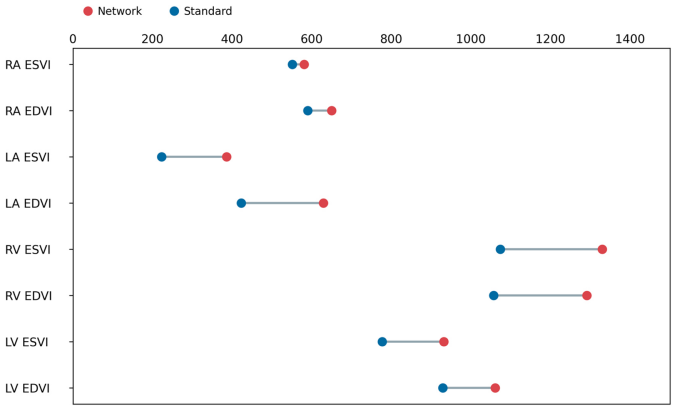

Table 1

	CVDn = 4723	No CVDn = 5733
Age (years)	67 (7)	63 (8)
Male	3,208 (68%)	2,961 (52%)
Weight (kg)	83 (16)	77 (17)
Height (m)	171 (9)	170 (11)
BMI (kg m^{-2})	28.3 (4.6)	26.4 (4.2)
SBP (adjusted, mmHg)	147 (21)	138 (20)
DBP (adjusted, mmHg)	86 (12)	82 (11)
Atrial Fibrillation	1,011 (21%)	NA
Heart Failure	339 (7.2%)	NA
MI or IHD	2,212 (47%)	NA
DM	1,490 (32%)	NA
Conduction defect	615 (13%)	NA
SCD or VA or ICD	138 (2.9%)	NA

Table 2

	Network		P-Value	Standard		P-Value
	CVD (n = 4723)	No CVD (n = 5733)		CVD (n = 4723)	No CVD (n = 5733)	
LV EDVI (ml/m^2)	83 (16)	85 (19)	<0.001	78 (16)	81 (20)	<0.001
LV ESVI (ml/m^2)	39 (10)	39 (11)	0.12	33 (11)	32 (11)	0.2
RV EDVI (ml/m^2)	88 (16)	92 (23)	<0.001	77 (15)	82 (22)	<0.001
RV ESVI (ml/m^2)	43 (10)	45 (14)	0.010	33 (9)	34 (12)	0.044

LA EDVI (ml/m²)	30 (13)	27 (8)	<0.001	17 (12)	14 (7)	<0.001
LA ESVI (ml/m²)	50 (14)	50 (12)	0.5	36 (14)	35 (12)	0.014
RA EDVI (ml/m²)	36 (15)	34 (11)	<0.001	26 (14)	25 (11)	0.3
RA ESVI (ml/m²)	57 (16)	59 (17)	<0.001	43 (16)	45 (16)	<0.001

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Argentine Registry of Cardiovascular Magnetic Resonance

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Background: The usefulness of cardiovascular magnetic resonance (CMR) has grown widely in the last few years and it is extremely important in clinical decision-making for numerous cardiovascular diseases. Different international registries have been published with relevant results about principal indications, image quality and clinical implications of CMR in Europe and in the United States, but we do not have this kind of data in middle-income countries.

Methods: A prospective registry was designed. Public and private health centers all over the country with the availability to perform a CMR scan were invited to participate. The initiative was developed and promoted by the CMR council of Argentine Society of Cardiology. Data of demographic, indications for CMR, complications associated, diagnoses and therapeutic consequences were collected.

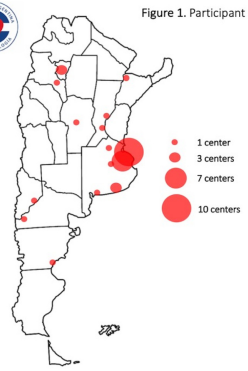
Results: 34 centers from 10 provinces of Argentina participated in the registry. Most of them were private (85%) with only one CMR scanner (74%) and 1.5 Tesla in 97.3%. Regarding the type of institution, 59% were centers with inpatient capacity and the remaining 41% were outpatient diagnostic centers.

A total of 1131 patients were included (mean age 54 ± 18 years and 61% males). Principal indications for CMR were hypertrophic cardiomyopathy (13.9%), ventricular arrhythmia (12.3%), dilated cardiomyopathy (9%), left ventricular dysfunction (7.3%), congenital disease (5.6%) and valvular disease (5.2%). The indication to search for ischemia (stress perfusion CMR) was only 4.9%. Regarding security, 99.7% of scans were reported with no complications, and only one patient (0.1%) had a severe adverse reaction (anaphylactic shock) after gadolinium injection. Good imaging quality were reported in 91.8% of studies and only 0.2% were considered unreportable by the physician in charge and the main reason was the presence of arrhythmia (54.4%) followed by poor hold breath (42.3%). The main results of CMR were normal (31.2%), non ischemic cardiomyopathy (14.7%), ischemic cardiomyopathy (11.6%), hypertrophic cardiomyopathy (8.9%) and moderate to severe valvular disease (5.8%). Clinical suspicion was confirmed in 23.6% of cases and CMR generated a new diagnosis in 48.7% of cases.

Therapeutic consequences were confirmed in only 275 patients (24.3%) and the most frequent were hospital discharge (31.6%), change in medication (28.1%), close follow up (18.9%) and avoidance of invasive procedure (12.7%).

Conclusion: CMR is widely used in Argentina, mainly in private centers with a very low incidence of complications. Principal indications for CMR are cardiomyopathies (hypertrophic and dilated) and ventricular arrhythmias and provides a new diagnosis in almost half of cases, with important clinical and therapeutic consequences.

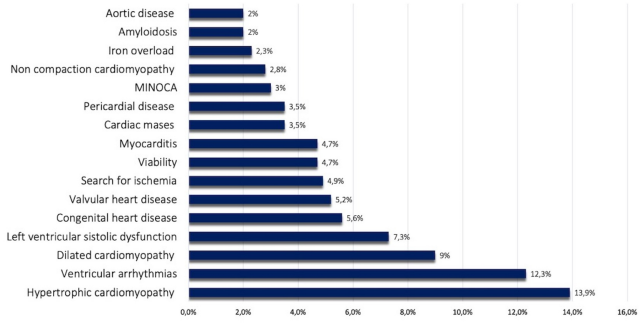
Figure 1. Participant centers of Argentine CMR registry



City	Nº of centers
City of Buenos Aires	10
Buenos Aires (Province)	7
Mar del Plata	3
San miguel de Tucumán	3
Junin	1
San Nicolas	1
Bahia Blanca	1
Bariloche	1
Neuquén	1
Córdoba	1
Comodoro Rivadavia	1
Corrientes	1
Rosario	1
Santa Fe	1
San Fernando del Valle de catamarca	1

- Total 34 centers
- 10 Provinces

Figure 2. Indications for CMR study in Argentina



MINOCA: myocardial infarction with no obstructive coronary arteries.