Comparison of Cardiac Output and Stroke Volume Estimates by Echocardiography, Bioreactance and Magnetic Resonance Imaging in Individuals with Hypertrophic Cardiomyopathy

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Introduction

- **Hypertrophic Cardiomyopathy (HCM)** is a genetically inherited cardiovascular disease affecting **1 in 500** of the general population [2].
- HCM results in an **enlarged interventricular septum**, reducing elasticity and surface area within the left ventricle causing decreased cardiac flow [3]
- **70%** of the HCM population **are obese** due to the fear and anxiety of experiencing a heart attack whilst exercising [4]
- **40% of sudden cardiac deaths (SCD)** in young athletes were caused by HCM. [5]

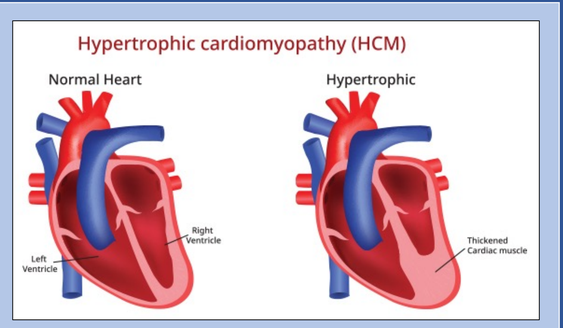

Figure 1 – Diagram identifying the difference in left ventricle wall thickness of a normal heart and a HCM heart. [1]

- **Diagnosis** of HCM can be completed via different types of imaging, with **Magnetic Resonance (MRI)** being the gold standard
- Other types include **Echocardiogram** and **Bioreactance**-based technology; **Non-invasive Cardiac Output Monitor (NICOM)**
- Left ventricle wall thickness of **≥15mm** resulting in adult diagnosis [6] while various measurements are also analysed to determine severity and treatment.

Aim: compare the data produced by MRI, Echocardiogram and NICOM imaging for different cardiovascular variables to assess the agreement between the three sets of data.

Method

- **12 participants** diagnosed with HCM underwent **MRI** (Figure 2), **Echocardiogram** (Figure 5) and **NICOM** (Figure 4) scans.
- **Cardiac Output** (CO), **Cardiac Index** (CI), **Stroke Volume** (SV) and **Stroke Volume Index** (SVI) were recorded from each scan per individual.
- **Segment** computer software was used to analyse the MRI data for each individual (Figure 3).
- **SPSS software** was used to statistically test the relationship between each analytical tool via **Bland-Altman plots**.

Figure 2 – Image of an MRI Scanner at the Newcastle Research Centre

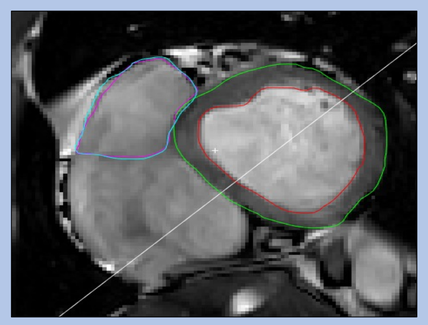

Figure 3 – Example of analysis in Segment software of MRI images of the HCM heart

Figure 4 – Image of a NICOM Device [7]

Figure 5 – Image of an echograph [6]

Results

Table 1 – Patient demographic and medication table

Demographics	*Mean ± SD*
Age (years)	52.9 ± 16.7
Height (cm)	171.4 ± 8.2
Weight (Kg)	82.0 ± 8.6
Body Mass Index (kg/m^2)	27.9 ± 2.3
Blood Pressure – Systolic (mmHg)	129.4 ± 13.1
Blood Pressure – Diastolic (mmHg)	78.6 ± 10.5
Medication	
Angiotensin-Converting Enzyme Inhibitors	0
Angiotensin Receptor Blockers (ARBs)	2
Beta-adrenergic Blocking Agent	5
Calcium Channel Blocking Agent	3
Diuretics	1
Diabetes	1
Anti-inflammatory	1
Statins	2
Anti-coagulants	4

- For **every cardiac parameter**, the **P value** was found to be **<0.05** across both Echocardiogram and NICOM when compared to MRI.
- A **significant statistical difference** was identified between the three methodologies
- **Figure 8** visually presents **the lack of agreement** between MRI and Echocardiogram for CO, further supporting the difference.

Table 1 – Comparison of MRI against Echocardiogram and NICOM measurements at rest

	MRI	Echocardiogram	NICOM
CO (L/min)	5.7 ± 0.8	3.1 ± 1.1***	4.1 ± 1.6**
CI (L/m^2/min)	2.9 ± 0.3	1.6 ± 0.5***	2.2 ± 0.7**
SV (mL)	95 ± 19.9	52.6 ± 17.8***	62.5 ± 25.5**
SVI (mL/beat/m^2)	48.0 ± 8.3	26.6 ± 8.4***	32.5 ± 11.5***

Key: * - p<0.05 ** - p<0.01 *** - p<0.001

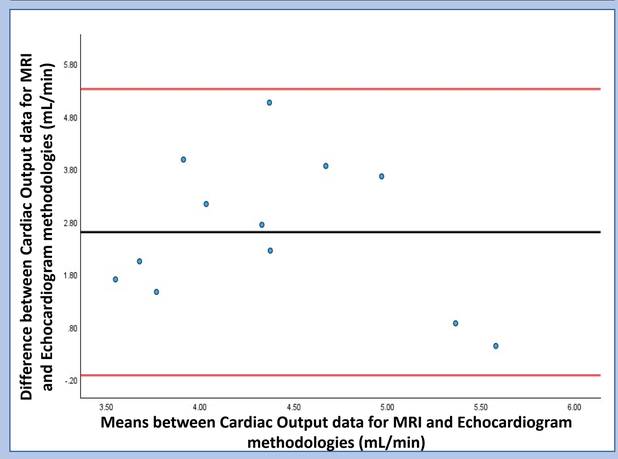

Figure 8 – Bland Altman plot to demonstrate the agreement between Cardiac Output in MRI and Echocardiogram at rest

Conclusion

- **Significant difference** identified when comparing gold standard MRI to alternative methodologies, therefore during practice, **only one methodology** should be designated and used consistently across future testing.
- **Important for clinicians** as utilising multiple methods to assess cardiac function in HCM may **produce false positive results**, leading to **incorrect medication/therapy treatments**.

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Funding: This study was funded by the **European Union's Horizon2020 Research** and **Innovation Programme under Grant Agreement 777204** for the **SILICOFCM project** and **Newcastle University Summer Research Scholarships Scheme**.