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Superior Reproducibility of Automated 3-D Surgical Anatomy of Normal and Abnormal Mitral Valve when Compared to a Manual Approach

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Abstract:

Background: Manual identification and contouring of landmarks to obtain quantitative 3-D parameters of the MV anatomy are tedious and have poor reproducibility. We tested whether an automated method to quantify the surgical MV anatomy was superior to the manual method. **Methods:** Real-time TEE data from 12 normals and 15 patients with functional MR (FMR) was used. QLab (Philips, Andover, MA, manual method) and a novel automated MV software (Siemens, Princeton NJ, automated method (IEEE Trans Medical Img 2010;29: 1636-50) were used to measure: antero-posterior and anterolateral-posteromedial (AP, ALPM) diameters, inter-commissural distance (ICD), anterior and posterior leaflet heights (ALH, PLH), and annular circumference (AC). We compared normal Vs. FMR, and assessed the inter- and intra-observer variability. **Results:** (mean SD, mm): As shown in Table 1, all the parameters were significantly increased in FMR compared to Normal. Only ICD is measured the same way by both methods and it was comparable in Normal (mean diff. 1.6 ± 0.8 , $p=0.1$) and FMR (mean diff. 1.7 ± 0.8 , $p=0.1$). Reproducibility data is shown in Table 2 and it was superior in the automated method for all parameters. Moreover, the range of variation in the measures was smaller in automated Vs. manual method: Normal 2 to 5% Vs. 2 to 14%, and FMR 2 to 8% Vs. 3 to 12%. The average time to complete quantification was 1- 2 minutes by automated Vs. 10-15 minutes by the manual method. **Conclusion:** Automated 3-D quantification of the surgical anatomy of normal and abnormal MV is feasible, time-efficient and more reproducible.

Table 1 Manual and Automated Measurements of Mitral Valve Anatomy

	Manual (QLab)		Automated	
	Normal	FMR	Normal	FMR
AP	35.3±4	40.9±5*	29.3±3	34.4±4†
ALPM	38.4±3	45.5±5†	34.9±3	40.6±4†
ICD	27.3±3	33.1±5†	25.4±3	31.0±4†
Trigone	-	-	24.1±3	28.3±2†
Ant LH	28.3±5	35.2±8*	21.3±3	26.9±5†
Post LH	18.7±3	21.4±3	15.5±1	18.2±2†
Circumference	125±13	144.6±17*	113.1±9	129.0±12†

Note: Inter-trigonal distance is *not* measured by QLab. The differences in the measurements by the Manual (QLab) and Automated methods reflect the differences in the landmarks used to compute these measures. However, the 2 methods individually, are able to detect differences between normal and FMR. * $p < 0.05$, † $p \leq 0.001$: Normal Vs FMR by both methods.

Table 2 Reproducibility (Inter and Intra observer variability)

	Manual-QLab				Automated			
	Normal		FMR		Normal		FMR	
	Inter	Intra	Inter	Intra	Inter	Intra	Inter	Intra
AP	0.90* (8±6%)	0.97* (2±2%)	0.90* (4±4%)	0.94* (3±3%)	0.95* (2±2%)	0.98* (2±2%)	0.97* (2±2%)	0.98* (2±2%)
ALPM	0.64 (6±4%)	0.97* (3±1%)	0.96* (2±2%)	0.97* (3±2%)	0.97* (2±2%)	0.94* (2±2%)	0.98* (2±2%)	0.96* (2±2%)
ICD	0.65 (14±1%)	0.84* (9±6%)	0.83* (8±5%)	0.97* (4±3%)	0.89* (5±4%)	0.84* (7±6%)	0.97* (4±4%)	0.93* (7±5%)
Trigone	NA	NA	NA	NA	0.87* (4±5%)	0.88* (5±4%)	0.90* (4±5%)	0.90* (5±4%)
ALH	0.37 (10±11%)	0.75* (9±7%)	0.83* (9±10%)	0.94* (6±4%)	0.98* (3±2%)	0.92* (5±6%)	0.98* (3±2%)	0.97* (5±6%)
PLH	0.95* (11±8%)	0.65* (12±6%)	0.86* (11±8%)	0.88* (12±14%)	0.88* (6±5%)	0.80* (8±7%)	0.88* (6±5%)	0.89* (8±7%)
AC	0.97* (4±3%)	0.97* (3±2%)	0.95* (3±3%)	0.95* (4±3%)	0.98* (1±1%)	0.97* (2±1%)	0.98* (1±1%)	0.99* (2±1%)

*p<0.05 (=statistically significant excellent/good reproducibility) in both methods

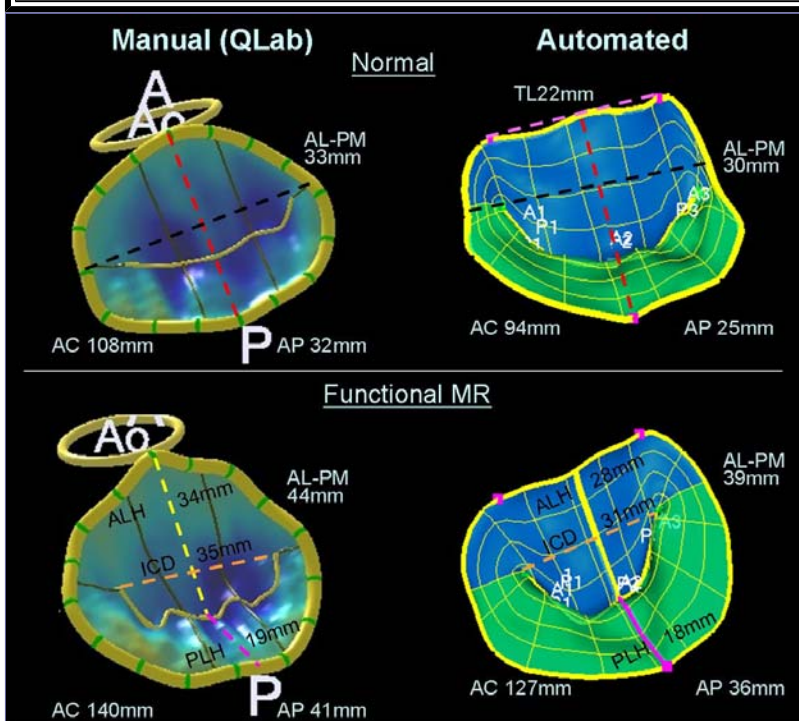


Figure shows a representative example of measurements in normal and FMR by manual and automated methods. All the measurements except the ICD (inter-commissural) distance are measured by using different landmarks and hence the difference. ICD is measured the same way and hence it is identical. Trigone length (TL) is measurable only by the automated method

Additional Consideration: YIA Competition:

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