Evaluation of two-dimensional echocardiography-derived tricuspid annular plane systolic excursion (TAPSE) in healthy dogs

Daniel J. Sintov and Lance C. Visser
Veterinary Medical Teaching Hospital, University of California, Davis

BACKGROUND

The clinical value of quantitative indices of right ventricular (RV) function is becoming increasingly apparent in dogs with cardiac disease. One index, **tricuspid annular plane systolic excursion (TAPSE)** conventionally acquired by M-mode echocardiography (MM TAPSE), has been shown to provide prognostic value in dogs with cardiac disease.[1] Canine MM TAPSE reference intervals have been published.[2,3] MM TAPSE may be limited by its acquisition angle-dependence and TAPSE quantified by 2D echocardiography (2D TAPSE) may overcome this limitation.[4]

The purpose of this study was: 1) To evaluate the feasibility, reproducibility, and measurement variability of 2D TAPSE vs MM TAPSE, 2) To determine the impact of bodyweight on 2D TAPSE, 3) To generate reference intervals for 2D TAPSE, and 4) To compare how 2D TAPSE and MM TAPSE track anticipated decreases in RV function post-atenolol. We hypothesized: 1) Measuring 2D TAPSE is feasible and reproducible with clinically acceptable variability in a large sample of healthy dogs. 2)2D TAPSE will track anticipated reductions in RV function post-atenolol.

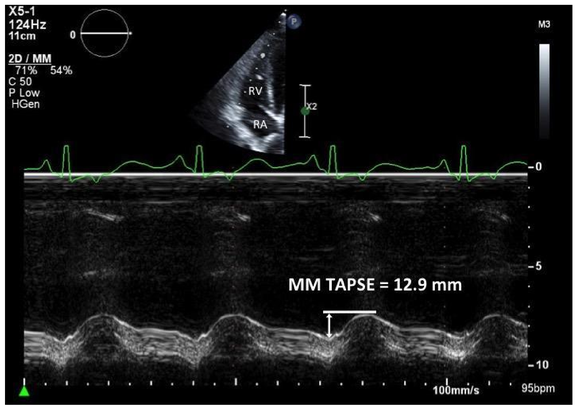

Figure 1. Representative measurement of M-mode echocardiography-derived TAPSE (MM TAPSE).

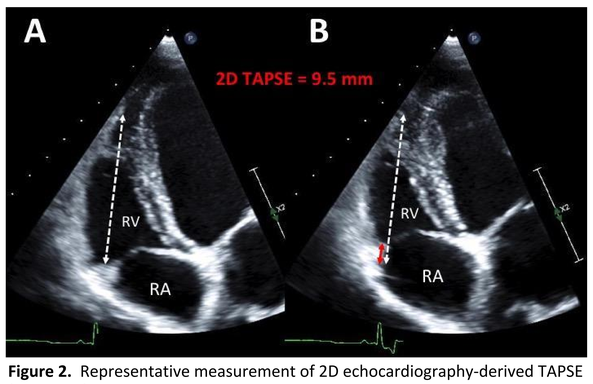

Figure 2. Representative measurement of 2D echocardiography-derived TAPSE (2D TAPSE).

MATERIALS & METHODS

Seventy-five healthy adult dogs underwent an echocardiogram to screen for cardiac disease and, if deemed normal, to generate reference intervals for 2D TAPSE. MM and 2D TAPSE measurements were performed as shown in **Figures 1 and 2**. As proof-of-concept, a subset of dogs (n=20) were administered a single oral dose of atenolol (temporarily reducing systolic function) following the baseline echocardiogram and re-imaged 3-hours post-pill. Another subset of dogs (n=10) underwent a second echocardiogram 1-2 hours after the first without intervention to assess within-day reproducibility. All measurements were performed by a single, blinded investigator. Reproducibility and measurement variability were assessed by the coefficient of variation. Regression analysis was used to evaluate the relationship between 2D TAPSE and bodyweight. Statistical comparisons were made using paired *t*-tests and significance was set to $P < 0.05$.

Table 1. Within-day reproducibility and intra- and inter-observer measurement variability of 2D TAPSE vs. MM TAPSE.

	Mean ± SD coefficient of variation (%)		
	2D TAPSE	MM TAPSE	*P*-value*
Within-day reproducibility (n = 10)	8.8 ± 6.3	8.7 ± 6.3	0.99
Intra-observer variability (n = 12)	7.9 ± 6.0	4.9 ± 6.8	0.31
Inter-observer variability (n = 12)	10.6 ± 7.6	6.3 ± 4.5	0.14

*Paired *t*-test

Table 2. Bodyweight-dependent reference intervals (95% prediction intervals) for 2D TAPSE derived from 70 healthy dogs.

Bodyweight (kg)	2D TAPSE (mm)
3	5.7 – 10.5
5	6.5 – 11.8
7	7.0 – 12.8
9	7.5 – 13.6
12	8.0 – 14.6
15	8.4 – 15.4
17	8.7 – 15.8
20	9.0 – 16.5
25	9.5 – 17.4
35	10.3 – 18.8
45	10.9 – 20.0
55	11.5 – 20.9
65	11.9 – 21.8

Calculated with the allometric equation: $Y = 4.42 – 8.06 \times \text{bodyweight}^{0.238}$.

RESULTS

Five dogs were excluded due to pre-existing cardiac disease or uncooperative temperament thus the study sample consisted of 70 dogs of varying breed, age, and bodyweight. 2D TAPSE and MM TAPSE were feasible to acquire in all dogs. Results of reproducibility and measurement variability studies are shown in **Table 1**. 2D TAPSE exhibited a significant nonlinear relationship ($r^2 = 0.53$; $P < 0.001$) with bodyweight and reference intervals were generated using allometric scaling based on the line of best fit and 95% prediction intervals (**Table 2; Figure 3**). Baseline mean ± SD 2D TAPSE was significantly higher compared to post-atenolol (11.7 ± 2.7 vs 10.4 ± 2.4 mm; P < 0.001 [**Figure 4**]). Mean ± SD percent change post-atenolol of 2D TAPSE vs MM TAPSE was not significantly different (-11.1 ± 7.4 vs -7.3 ± 14.6 %; P = 0.33 [**Figure 5**])

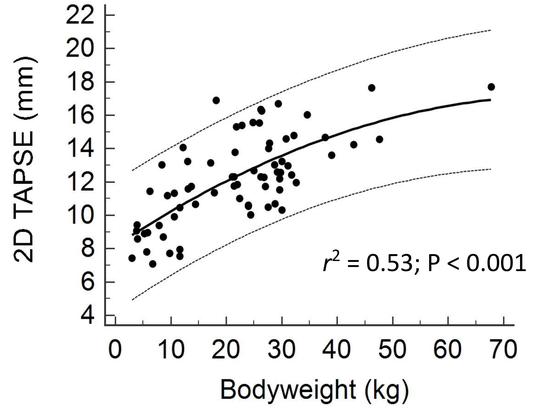

Figure 3. Scatter plot demonstrating the significant nonlinear relationship between 2D TAPSE and bodyweight in 70 healthy dogs. Black line represents the line of best fit and dotted lines represent the 95% prediction intervals used to generate reference intervals.

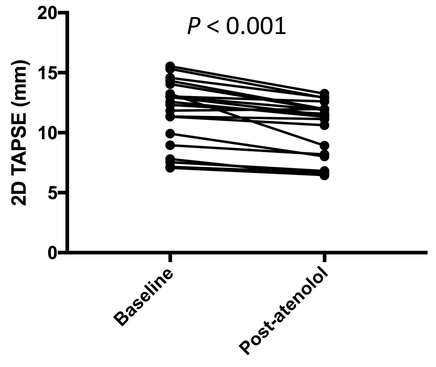

Figure 4. 2D TAPSE at baseline and 3-hours post-atenolol (1-1.5 mg/kg PO) in 20 healthy dogs.

CONCLUSIONS

- 2D TAPSE is feasible to acquire and reproducible, and demonstrates clinically acceptable measurement variability in a large and diverse sample of healthy dogs.
- 2D TAPSE is bodyweight-dependent and clinically applicable reference intervals are available.
- 2D TAPSE was able to reliably track anticipated reductions in RV systolic function post-atenolol.
- 2D TAPSE behaves similarly to MM TAPSE with regard to reproducibility, measurement variability, bodyweight-dependence and the ability to track changes in RV function.
- 2D TAPSE provides a reliable alternative angle-independent method to quantify RV systolic function and is likely useful during instances of M-mode cursor malalignment or for retrospective comparisons.
- Future studies are warranted to determine the clinical value of 2D TAPSE in dogs with cardiovascular disease.

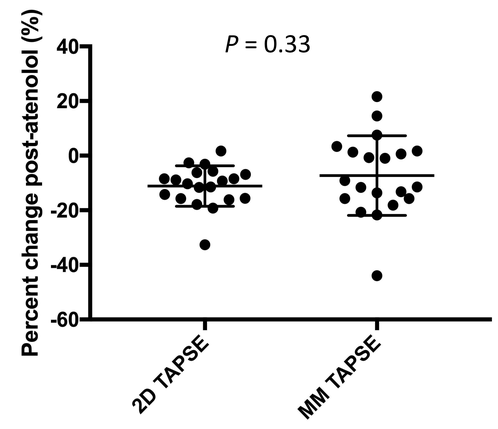

Figure 5. Scatter dot plots of percent change in 2D TAPSE and MM TAPSE post-atenolol in 20 healthy dogs. Bars and error bars represent mean ± SD.

REFERENCES

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ACKNOWLEDGEMENTS

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