Feasibility of Transthoracic Imaging of the Heart in the Prone Position

Transthoracic echocardiography (TTE) in the prone position is a nonconventional approach that is not routinely performed for cardiac assessment. The need for prone TTE has increased recently because of the needs of the coronavirus disease 2019 (COVID-19) patient population.[1,2] With a few adjustments to the traditional transthoracic scanning method, we believe we can adequately evaluate myocardial function and detect subclinical impairment while a patient is in the prone position. Because of its feasibility and portability, TTE is the principal imaging modality used to monitor the cardiac function of patients with COVID-19.[3]

In this single-center, prospective study, TTE was performed, using a state-of-the-art ultrasound platform, on 24 nonintubated patients without COVID-19 in both the traditional (left lateral decubitus) and prone positions. This study was designed to test the feasibility and compare the quantitative results of traditional versus prone imaging. Ugalde *et al.*[4] described a modified prone position as the "swimmer's position." The swimmer's position is accomplished by having the patient lie on his or her stomach with the left arm raised above the head and the right arm resting along the torso. A pillow should be propped under the left arm to slightly elevate the left-sided rib cage, permitting more space for the transducer. If the imager is scanning with the right hand, no system relocation is necessary. If the imager is scanning with the left hand, the system will be located on the patient's right side and placed at the foot of the bed. When connecting the patient to the ultrasound system, electrocardiographic patches can be placed on the patient's back if the chest is not obtainable (Supplemental Video 1, available at www.onlinejase.com).

The following views were attempted in the prone position: parasternal long-axis, apical four-chamber, apical two-chamber, apical long-axis, right ventricular (RV)–focused, and inferior vena cava (IVC). The following measurements were obtained when imaging quality was adequate: RV inflow E wave, tricuspid annular peak systolic velocity (S′), RV systolic pressure, and IVC dimension during inspiration and expiration.

Categorical values are summarized as counts and percentages. Continuous variables are presented as mean ± SD. Echocardiographic parameters and longitudinal strain parameters were compared in the traditional and prone echocardiographic positions using either a paired t test or a Wilcoxon signed rank test. Statistical significance was defined as a two-sided P value <.05.

This study demonstrates that TTE is feasible with the patient in the prone position. The dedicated RV view was obtained in 100% of patients imaged, the apical four-chamber view in 95.8%, the apical long-axis view in 79.2%, the apical two-chamber view in 45.8%, and the transhepatic IVC view in 33.3%; the parasternal long-axis view was not visualized in any of the patients (0%).

There was no statistical difference observed between the measurements recorded in the traditional and prone imaging positions. Left ventricular (LV) global longitudinal strain (GLS) had similar results (−17.7 ± 3.19% vs −17.7 ± 5.49%, P < .69), as did RV longitudinal strain (RVLS; −23.5 ± 4.39% vs −22.9 ± 5.65%, P < .99), in the traditional and prone positions. RVLS had a much higher feasibility rate (70.8%, n = 17) than LV GLS (25%, n = 6) in the prone position. RV S′ had the highest feasibility (95%, n = 23), with a mean of 0.12 ± 0.03 versus 0.14 ± 0.03 m/sec (P < .09). RV systolic pressure had one of the lowest feasibility rates (45.8%, n = 11) with similar values (30.8 ± 13.44 vs 32.3 ± 7.89 mm Hg, P < .55). RV inflow was analyzed (62.5%, n = 15), with little difference (0.52 ± 0.21 vs 0.54 ± 0.26 m/sec, P < .21), as well as IVC diameter during inspiration (0.88 ± 0.72 vs 1.15 ± 0.62 cm, P < .45) and expiration (1.74 ± 0.68 vs 1.94 ± 0.4 cm, P < .73). IVC diameter at inspiration and expiration had the same feasibility (33.3%, n = 8; Table 1).

This study illustrates that RV-focused imaging was feasible in 100% of patients, including a high feasibility rate of analysis of RV systolic parameters such as RVLS (Figure 1). The right ventricle could be easily visualized in the prone population, most likely because the heart slides closer to the chest wall, thereby allowing less penetration and better visualization of ultrasound waves. The apical four-chamber

Table 1 Echocardiographic parameters in the traditional and prone positions

Variable	Traditional	*n* (24 total)	Prone	*n* (24 total)	*P*
LV GLS, %	−17.7 ± 3.19	19	−17.7 ± 5.49	6	.69
	−18 (−18.9 to −16.3)		−18.4 (−20.1 to −15)		
RVLS, %	−23.5 ± 4.39	18	−22.9 ± 5.65	17	.99
	−24.7 (−26.5 to −22)		−25 (−25.7 to −20)		
RV S′, m/sec	0.16 ± 0.17	24	0.14 ± 0.03	23	.09
	0.13 (0.11 to 0.14)		0.13 (0.12 to 0.15)		
RVSP, mm Hg	30.8 ± 13.44	20	32.3 ± 7.89	11	.55
	26.7 (22.2 to 35.8)		32.2 (23.1 to 39)		
RV inflow E wave, m/sec	0.52 ± 0.21	16	0.54 ± 0.26	15	.27
	0.49 (0.42 to 0.55)		0.50 (0.42 to 0.53)		
IVC diameter inspiration, cm	0.88 ± 0.72	22	1.15 ± 0.62	8	.45
	0.8 (0.6 to 1.2)		1.15 (0.85 to 1.65)		
IVC diameter expiration, cm	1.74 ± 0.68	22	1.94 ± 0.40	8	.73
	1.75 (1.3 to 2)		1.95 (1.6 to 2.3)		

RVSP, RV systolic pressure.
Data are presented as mean ± SD and median (interquartile range).

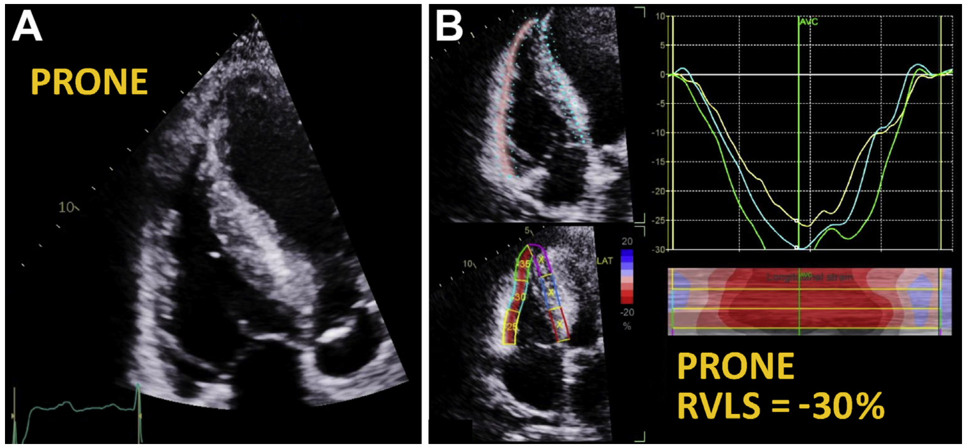

Figure 1 Prone RVLS analysis. This figure demonstrates TTE of the dedicated RV view in the prone position **(A)** with corresponding RVLS analysis **(B)**.

view was also visualized in a majority of patients, providing an idea of global LV systolic function. However, the other views required for LV GLS assessment were not as easily obtainable, yielding a much lower rate of LV GLS than RVLS. Prone imaging was deemed more challenging if the patient had a more medial window in the traditional position because of the challenge of sliding the probe medially and interference with the examination table while in the prone position. This also explains why the parasternal long-axis view was unattainable and the IVC was analyzed only transhepatically. Studies have been conducted of the use of smaller or handheld ultrasound devices. We believe that similar results are achievable, with the exception of longitudinal strain analysis, which is often not available on smaller platform models.

We acknowledge that this is a pilot study of the feasibility of TTE in the prone position, and we did not include patients infected with COVID-19 or on mechanical ventilation. Now that we know that this is achievable, the target population needs to be formally evaluated, as COVID-19 and mechanical ventilation could affect image quality, heart position, and associated RV abnormalities. During the surge of the pandemic, prone TTE was possible in a small group of patients, but further analysis is warranted.

TTE in the prone position is a feasible examination choice, with few modifications necessary. A sufficient focused study can be performed, yielding necessary data for adequate assessment of myocardial injury. In the midst of the COVID-19 pandemic, RV functional analysis, especially RVLS, has been a proven powerful predictor of mortality in this patient population.[5]

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SUPPLEMENTARY DATA

Supplementary data related to this article can be found at https://doi.org/10.1016/j.echo.2020.07.004.

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