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BRIEF COMMUNICATION

Effects of his bundle pacing on global work efficiency in post-cardiac surgery patients

Davide Romagnolo MD[1] | Luca R. Limite MD[2] | Basma El Sawaf MSc[2] | Giacomo Ingallina MD[1] | Carlo Gaspardone MD[3] | Davide A. Morciano MD[1] | Gabriele Paglino MD[2] | Patrizio Mazzone MD[2] | Eustachio Agricola MD[1] | Paolo Della Bella MD[2]

[1]Cardiovascular Imaging Unit, IRCCS San Raffaele Scientific Institute, Milan, Italy

[2]Arrythmology Unit, IRCCS San Raffaele Scientific Institute, Milan, Italy

[3]Clinical Cardiology Unit, IRCCS San Raffaele Scientific Institute, Milan, Italy

Correspondence
Davide Romagnolo, MD, Cardiovascular Imaging Unit, IRCCS San Raffaele Scientific Institute, Via Olgettina, 60, 20132 Milan, Italy.
Email: romagnolo.davide@hsr.it

Current address for correspondence at time of publication: Davide Romagnolo, MD, Cardiac Intensive Care Unit, IRCCS Humanitas Research Hospital, Via Manzoni, 56, 20089, Rozzano (Milan), Italy.
Email: davide.romagnolo@humanitas.it

KEYWORDS
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His Bundle Pacing (HBP) aims to preserve intra- and interventricular mechanical synchrony engaging physiological conduction through the His-Purkinje system.[1] Atrio-ventricular (AV) block is a frequent complication after cardiac surgery (CS), occurring in up to 8.8% of patients, often requiring definitive pacing which may result in dyssynchrony and systolic dysfunction.[1] HBP is safe and effective in patients with prior CS[1] reducing the risk of heart failure hospitalization compared with right ventricular pacing (RVP).[2] Additionally, compared with cardiac resynchronization therapy (CRT), HBP is much less invasive, as it does not require an additional lead in the coronary sinus.

Various echocardiographic indices of mechanical dyssynchrony have been proposed to predict response to CRT, but they showed limited accuracy.[3] Global Work Efficiency (GWE), derived from Speckle Tracking Echocardiography (STE) combined with noninvasive blood pressure recording, can carefully detect temporal dispersion of mechanical systole and has been proposed to predict the response to CRT.[4] However, there is still a significant knowledge gap regarding the effects of HBP on GWE, as its exploration has been limited to a small single-center study[5] and there is a lack of evidence specifically in the context of post-CS patients. Therefore, the aim of this study is to investigate the effects of HBP on GWE in a nonselected cohort of post-CS patients.

From December 2018 to May 2021, we enrolled 27 consecutive post-CS patients (21 men, 77%; mean age 72 ± 10 years) who underwent HBP implantation due to AV block. Of the patients, 10 (37%) had previously undergone coronary artery bypass grafting, while 17 (63%) had history of left-sided valve surgery. The implantation of HBP was performed by two experienced operators (L.R.L., G.P.), and a right ventricular (RV) back-up lead, placed at the RV apex, was used in patients with complete heart block (10, 37%). Follow-up was conducted at a median time of 10 months (IQR 3–24) postimplantation.

Device interrogation and comprehensive transthoracic echocardiography were conducted by an experienced technician (B.E.S.) and two experienced cardiologists (D.R., G.I.), respectively, during HBP ($n = 27$),

Abbreviations: AV, atrio-ventricular; CRT, cardiac resynchronization therapy; CS, cardiac surgery; GWE, global work efficiency; HBP, his bundle pacing; RV, right ventricular; RVP, right ventricular pacing; SR, spontaneous rhythm; STE, speckle tracking echocardiography.

Davide Romagnolo and Luca R. Limite equally contributed to the article and should be considered as shared first authors.

RVP (in patients with RV backup lead, $n = 10$) and spontaneous rhythm (SR, $n = 14$). SR emerged in 14 patients (52%) and included atrial fibrillation in 5 patients (29%) and sinus rhythm with advanced AV block in 9 patients (33%). During echocardiography, in instances where SR emerged over the paced rhythm, the lower rate for HBP and RVP was adjusted to ensure a persistent pacing throughout the examination. The median programmed lower rate at the time of echocardiography was 70 bpm (IQR 60–80).

Echocardiographic examinations were performed using a GE Vivid E95 ultrasound system equipped with a 4Vc-D cardiac probe, and offline postprocessing was carried out using EchoPAC software V.202 (GE Healthcare, Chicago, IL, USA). Since electrophysiological and echocardiographic follow-up assessments are part of routine evaluation after CS and pacemaker implantation in our institution, and no additional examination was performed for the sake of this study, the local ethical committee waived the requirement for approval. Comparison between baseline and follow-up assessment was performed using paired Student's *t*-test or Wilcoxon, as appropriate, while the comparison of GWE between the three groups was performed using the ANOVA and unpaired *t*-test. A significance level of $p < .05$ was adopted for all statistical tests.

At follow-up, median stimulated QRS duration during HBP was similar to native QRS duration at baseline (119 vs. 100 ms; $p = .249$), as well as the ejection fraction (55.0% vs. 55.5%, $p = .467$). Median percentage of stimulation was 100% (IQR 98–100). No significant change in HBP capture thresholds was observed between baseline and follow-up (1.25 vs. 1.40 mV, $p = .997$, and 0.40 vs. 0.75 ms, $p = .862$), as well as no change in R wave sensing (4.0 vs. 3.9 mV $p = .930$). Only one patient experienced HBP failure, due to lead displacement requiring repositioning. No adverse events such as pneumothorax, pericardial effusion, and device-related infection were observed.

ANOVA revealed a significant difference in GWE between RVP, HBP and SR ($p = .010$), as illustrated in Figure 1. Specifically, SR resulted in a significantly improved GWE compared with RVP (88.8% vs. 82.5%; $p = .035$), while no difference was observed between HBP and SR (88.8% vs. 87.6%; $p = .404$). Similarly, a trend towards improved GWE emerged when comparing HBP with RVP (87.6% vs. 82.5%, $p = .076$), despite not meeting statical significance, possibly due to small number of RVP patients ($n = 10$). Our results are in accordance with a previous study,[5] conducted in a small cohort of nonsurgical patients, suggesting an increase in GWE when comparing HBP to RVP. The higher GWE observed in SR and HBP reflects improved contractile performance, increasing the fraction of work successfully participating in contraction and relaxation with minimal change in total work and may suggest better outcomes in these patients compared with RVP.[2,6] Accordingly, GWE may identify patients who take the most advantage from HBP.

In conclusion, our proof-of-concept study proves that HBP is a safe and effective treatment for post-CS patients requiring definitive stimulation, preserving GWE in comparison to RVP, and resulting in similar contractile efficiency to SR. However, it is important to point out that our study is limited by its small size, unblinded design, and its findings are specific to post-CS population. Additionally, our study lacks invasive hemodynamic parameters, such as measurements of RV pressure and right atrial pressure variation during pacing and SR, which could offer valuable insights into the mechanistic underpinnings of the observed effects and enhance the robustness of our conclusions. Therefore, further research is necessary to validate these preliminary results.

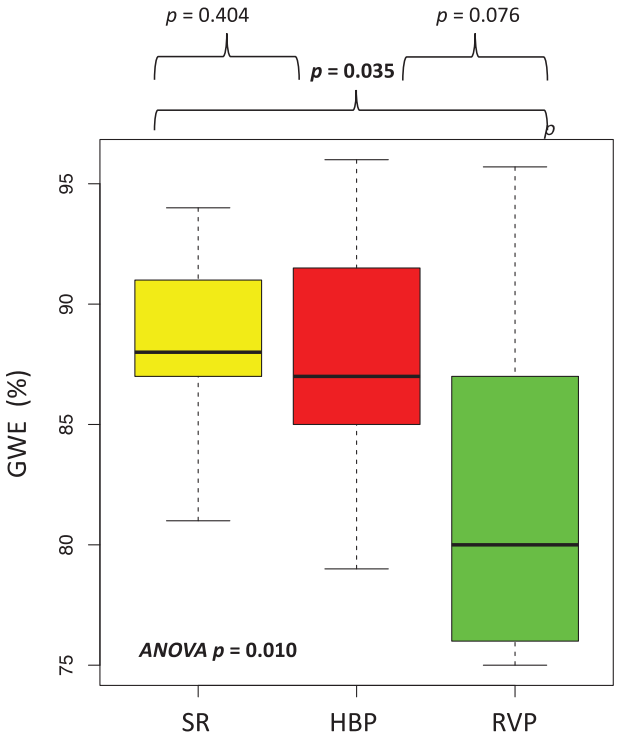

FIGURE 1 GWE during SR, HBP, and RVP. GWE, global work efficiency; HBP, his bundle pacing; RVP, right ventricular pacing; SR, spontaneous rhythm. [Color figure can be viewed at wileyonlinelibrary.com]

AUTHOR CONTRIBUTIONS

Davide Romagnolo: concept, data analysis, drafting article, statistics, data collection. Luca R. Limite: concept, data collection, data analysis, critical revision of article. Basma El Sawaf: data collection. Giacomo Ingallina: concept, interpretation, critical revision of article. Carlo Gaspardone, Davide A. Morciano: visualization, interpretation, critical revision of article. Gabriele Paglino, Patrizio Mazzone, Eustachio Agricola, Paolo Della Bella: resources, supervision.

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DATA AVAILABILITY STATEMENT

The data used in this study are available upon request from the corresponding author, subject to restrictions and compliance with relevant data protection regulations. This paper is not under consideration elsewhere. None of the paper's contents were previously published. All authors have read and approved the manuscript. All authors report no conflict of interest related to the work in the manuscript. All authors meet the criteria for authorship.

ORCID

Davide Romagnolo MD https://orcid.org/0000-0002-1576-0972
Luca R. Limite MD https://orcid.org/0000-0003-1600-3137

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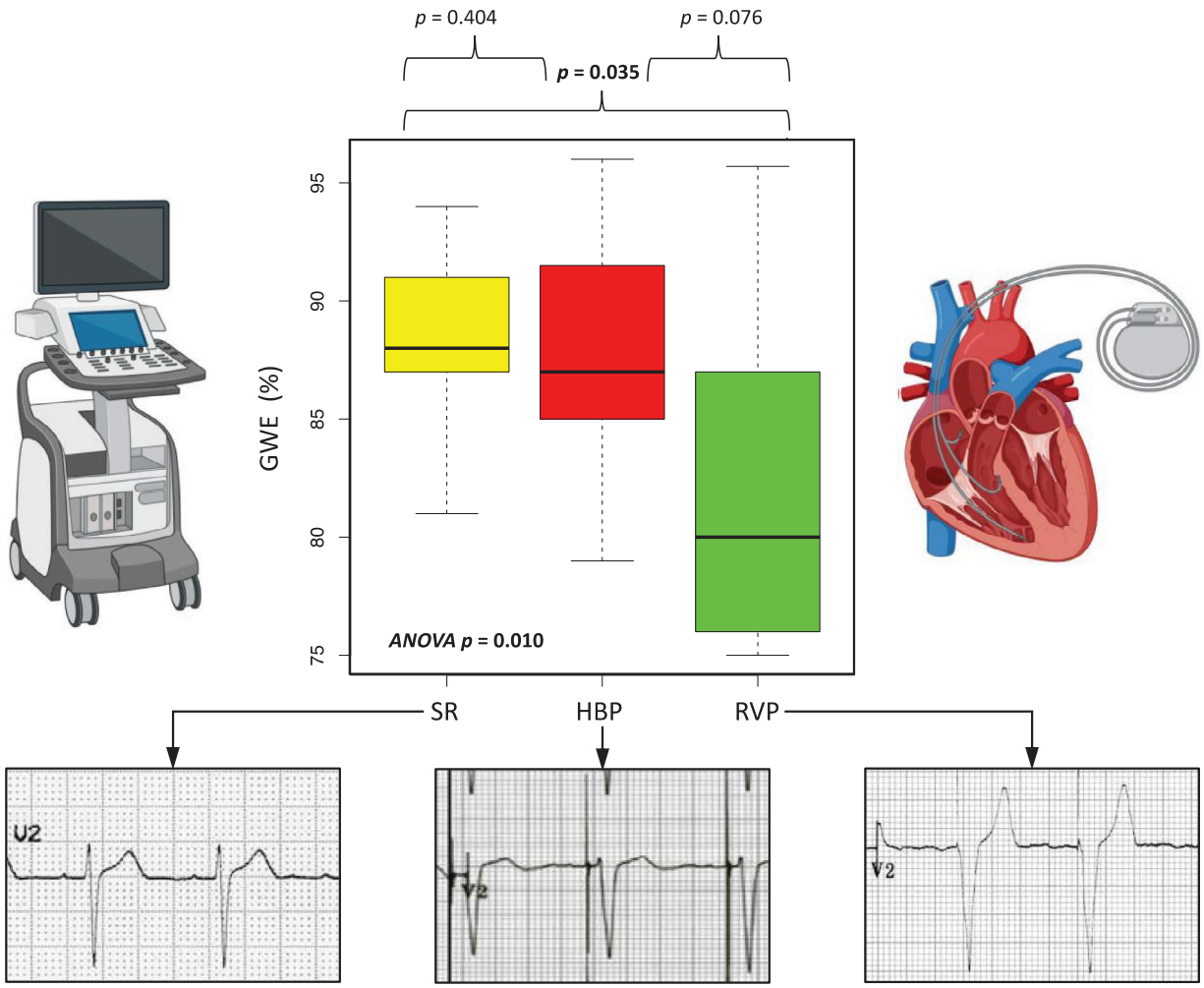

Central Figure Impact of RVP and HBP on GWE compared with SR. HBP, characterized by improved electromechanical synchrony as denoted by shorter QRS duration, demonstrates similar GWE to SR. Conversely, RVP, associated with electromechanical dispersion and larger QRS duration, exhibits significantly lower contractile efficiency. Created with *BioRender.com*. GWE, global work efficiency; HBP, his bundle pacing; RVP, right ventricular pacing; SR, spontaneous rhythm.