

## Observation of Biotronik Congestive Heart Failure Systems (BEATLE): First Results of a Post-Market Surveillance

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### Summary

*Congestive heart failure is a progressive disease that is characterized by progressive left ventricular dilatation and loss of contractile function, often accompanied by interventricular conduction disturbances. The integration of the left ventricle into the pacemaker therapy of patients with severe heart failure and conduction disturbances appears to be very promising. It has been shown that biventricular stimulation might increase the load tolerance and quality of life of these patients. This article describes the first results of the BEATLE post-market surveillance, which used the recently developed Corox LV-H lead. The lead fixation in the coronary vein system is optimized by a helix-shaped distal area. The BEATLE study was able to demonstrate that biventricular stimulation via the coronary vein using the existing resynchronization systems can be conducted safely and successfully.*

### Key Words

Biventricular stimulation, heart failure, post-market surveillance

### Introduction

Today, there is a large and rapidly increasing population afflicted with congestive heart failure (CHF). In Europe, there are over 6.5 million patients with this diagnosis, and annually 580,000 new cases are added [1]. For hospitalized patients who are over 65 years of age, CHF is the most frequently presented diagnosis [2]. For this reason, the treatment of CHF is also associated with considerable socio-economic consequences. In approximately 30% of CHF patients, the disease is manifested not only through a decrease of the heart's ejection fraction, but also as a disturbance in ventricular contraction. As a consequence, contractions in the right and left ventricles are shifted chronologically against one another [3]. This disturbance becomes clearly evident through a widening of the QRS complex in the surface ECG. In the current

research, the appearance of such an interventricular delay is associated with an increased risk of mortality [4-7]. The results in recent scientific publications indicate that resynchronization of the heart's contractions produces a potential benefit for selected patients with CHF. This is guaranteed by a simultaneous stimulation of both ventricles. Initial study results have shown that atrio-synchronous, biventricular stimulation improves cardiac performance and, consequently, increases the load tolerance and quality of life of these patients [8-16].

The data presented here are the preliminary results from the observation of Biotronik congestive heart failure systems (BEATLE), in which the included study participants were observed over a period of 6 months after implantation of a resynchronization system.

	<b>Age (years)</b>	Mean $\pm$ SD Range	70 $\pm$ 8 44 – 82
	<b>Gender, male</b>		17 (65%)
	<b>Ischemic etiology</b>		17 (65%)
<b>EKG Analysis</b>	<b>Mean heart rate at rest (beats/min)</b>	Mean $\pm$ SD Range	77 $\pm$ 16 40 – 100
	<b>PR interval (ms)</b>	Mean $\pm$ SD Range	198 $\pm$ 38 150 – 300
	<b>QRS-width (ms)</b>	Mean $\pm$ SD Range	150 $\pm$ 24 100 – 200
<b>Echocardiographic Analysis</b>	<b>LVEF (%)</b>	Mean $\pm$ SD Range	27 $\pm$ 7 12 – 40
	<b>NYHA Class</b>		
	<b>II – III</b>		6
	<b>III</b>		12
	<b>III – IV</b>		2
	<b>IV</b>		2
	<b>Not documented</b>		4

Table 1. Patient characteristics. SD = standard deviation, LVEF = left ventricular ejection fraction.

## Material and Methods

### Patients

The precise characteristics of this patient population are represented in Table 1. The symptoms documented most frequently in connection with heart failure were shortness of breath (73%), edema (42%), and fatigue (39%). All patients were receiving cardiovascular drug

therapy. This included the administration of beta-blockers (65%), digitalis (50%), nitrates (35%), ACE inhibitors (54%), diuretics (69%), spironolactones (54%), and anticoagulants (31%).

### Resynchronization System

Patients with an ICD indication were treated with a Tupos LV (Biotronik, Germany), and patients without such an indication with a Triplos LV (Biotronik) pacemaker (Figures 1 and 2). Both resynchronization systems have a three-channel header with connection possibilities for bipolar right atrial and right ventricular leads, as well as an unipolar coronary sinus (CS) lead for stimulation of the left ventricle. With resynchronization switched on, simultaneous cathodal stimulation of both ventricles occurs.

### LV Leads

Both CS leads used in this study (Corox LV-P and Corox LV-H, both Biotronik) offer two different anchoring mechanisms that are optimally suited to the various interindividual anatomies of the coronary vein system (Figure 3). The atraumatic fixation of the Corox LV-P occurs by means of a curve at the distal tip. With the recently developed Corox LV-H, the distal area is helix-shaped. Both leads facilitate a differentiated steering of the lead in the coronary vein system by partial withdrawal of the stylet.

### Implantation Tool

The SCOUT implantation accessory consists of a guiding catheter with a hemostatic vent, a balloon catheter, and a probing catheter. The guiding catheter consists of



Figure 1. Tupos LV (Biotronik, Germany).



Figure 2. Triplos LV (Biotronik, Germany).

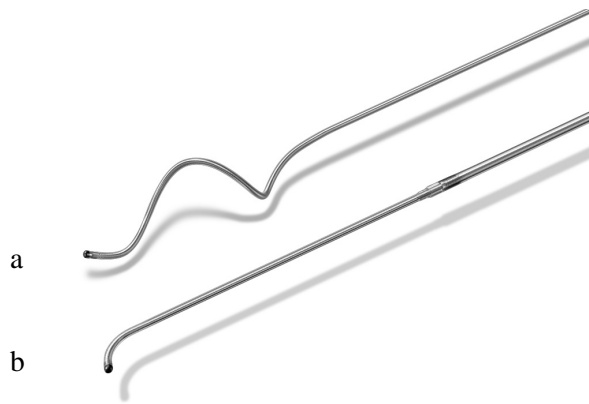


Figure 3. Corox LV-H (a) and Corox LV-P (b; both from Biotronik, Germany).

a plastic tube with a shore hardness that decreases in stages and a tip composed of very soft material. The outer diameter of the guiding catheter is 10 F. The tube has a curve at the distal tip that will facilitate the probing of the CS. In addition, the interior is provided with a lubricated coat in order to reduce any friction between the lead and the guiding catheter. The balloon catheter (6 F, 80 cm) is constructed with two lumens. One lumen is intended for the delivery of contrast media, while the other is designed to inflate and deflate the balloon located near the catheter tip (max.  $\varnothing$  1 cm). The probing catheter is based on the principle of an electrophysiologic mapping catheter. The catheter tip can be controlled directly using the push-pull technique. The probing catheter is used when it is not possible to attain a stable position in the ostium of the CS using only the guiding catheter.

<b>Right Ventricle</b>	Kainox (Biotronik)	5
	Merox(Biotronik)	4
	Polyrox (Biotronik)	2
	Synox (Biotronik)	3
	Tirox (Biotronik)	1
	1472 T (St. Jude)	3
	Not documented	5
<b>Left Ventricle</b>	Corox LV- P (Biotronik)	6
	Corox LV-H (Biotronik)	16
	Not documented	1

Table 2. Lead types implanted in the right and left ventricle.

### Implantation

As a rule, implantation of these leads occurred via a puncture of the left subclavian vein. In three cases involving an upgrade of a dual-chamber system to a resynchronization system, the implantation was performed on the right side.

### Implantation Using the SCOUT Implantation Tool

After puncturing the subclavian vein, a guide wire is positioned in the venous system through which the guiding catheter is advanced into the right atrium. Afterwards, an attempt is made to probe the ostium of the CS and to anchor the guiding catheter in a stable position. This probing can be facilitated by using the SCOUT (Biotronik) tracing tool. Afterwards, a balloon catheter is introduced into the CS via the guiding catheter and a venogram is performed, which helps to determine the optimal target vein for implantation of the left ventricular (LV) lead. After removal of the balloon catheter, placement of the LV lead occurs with the help of a stylet. By slightly pulling back the stylet, the distal pre-shape of the lead can be used to access the target vein. By introducing the stylet again, the lead is again straightened and introduced deeper into the vein. After removal of the stylet, passive fixation of the lead occurs on the basis of its distal shape. Afterwards, a measurement of the electrical parameters was carried out with an external threshold measurement device. Then the guiding catheter was removed using the Peel-Away technique.

### Results

In total, 23 implantations were conducted successfully, which corresponds to an intraoperative success rate of 88%. In the other three cases, it was not possible to safely fixate the LV lead in a position with an adequate threshold. The Triplos LV was implanted in 15 patients; with the remaining eight there was an indication for an ICD, which led to the implantation of a Tupos LV. Table 2 shows an overview of the implanted leads. With 14 of the successful implantations, the implantation technique described above was used; in nine cases, the LV lead was implanted without the implantation tool. On average, the implantations lasted  $136 \text{ min} \pm 48 \text{ min}$  (range: 70 – 255 min) with a total fluoroscopy time of  $42 \text{ min} \pm 25 \text{ min}$  (11 – 105 min). In ten cases (44%), the LV lead was implanted in the lateral coronary vein, in five cases (22%) in the antero-

		Intraoperatively				Discharge		6-week Follow-up	
		RA	RV	LV	BiV	RA	BiV	RA	BiV
Threshold (V)	Mean	1.0	0.6	1.1	1.5	1	1.7	1.2	2.3
	± SD	0.3	0.3	0.6	0.9	0.7	0.8	0.4	1.3
	Range	0.4 – 1.7	0.3 – 1.2	0.4 – 3.0	0.4 – 2.9	0.3 – 2.7	0.6 – 3.4	0.7 – 2.0	0.5 – 5.4
Sensing (mV)	Mean	2.4	14.4	15.5	17.4	2.0	9.6	2.2	12.2
	± SD	0.9	6.7	7.4	6.7	0.9	5.8	0.9	4.6
	Range	0.8 – 5.0	2.8 – 24.5	4.5 – 33.0	9.0 – 31.4	1.1 – 4.3	2.8 – 20.6	1.0 – 3.9	4.0 – 20.0
Impedance (Ω)	Mean	490	749	845	446	363	312	406	350
	± SD	114	219	156	121	180	112	221	91
	Range	360 – 824	466 – 1232	560 – 1156	268 – 753	193 – 753	181 – 530	239 – 1090	211 – 550

Table 3. Clinical data from intraoperative measurements, discharge follow-up and 6-week follow-up for different settings. (RA = right atrial, RV = right ventricular, LV = left ventricular, BiV = biventricular).

lateral, in two cases (9%) in the posterolateral, and in three cases (13%) in the great cardiac vein. In three cases, the final position was not documented.

Table 3 shows an overview of the intraoperative lead parameters for the discharge examination and the 6-week postoperative follow-up examination. An evaluation of the intraoperative ECG recordings revealed an average reduction of the QRS-width of  $161 \text{ ms} \pm 27 \text{ ms}$  ( $100 \text{ ms} - 200 \text{ ms}$ ) and  $137 \text{ ms} \pm 16 \text{ ms}$  ( $110 \text{ ms} - 160 \text{ ms}$ ) below biventricular stimulation, respectively. With purely right ventricular stimulation, the QRS-width increased to  $171 \text{ ms} \pm 25 \text{ ms}$  ( $140 \text{ ms} - 217 \text{ ms}$ ). In the course of the 6-week follow-up, complications appeared in four cases. In two cases, phrenic nerve stimulation was observed, which was eliminated each time by reprogramming the device. In one case, an increase in the biventricular threshold occurred, which likewise could be compensated by adjusting the programming. In one case, no more resynchronization was observed in the follow-up study. As a result, the LV lead was repositioned during another intervention.

## Discussion

The BEATLE study was able to demonstrate that with these resynchronization systems, biventricular stimulation via the coronary vein can be conducted safely and

successfully. Certainly, through further development of the implantation aids an improvement of the implantation performance is still possible. In particular, a further shortening of the implantation times as well as fluoroscopy duration is to be sought in order to avoid overstressing this patient population due to an unnecessarily long operative period. With the unsuccessful implantations, the LV lead could not be fixated to positions with an adequate threshold. A further development of the lead portfolio might make it possible to place and fixate the lead more frequently at the desired site. The LV leads demonstrated very good electrical parameters intraoperatively and in chronic cases were comparable with published results [17]. The threshold that is higher in comparison with the interoperative measurement at the 6-week postoperative follow-up can be explained by the in-growth response of the electrode. Here the chronic status after 6 months remains to be seen. Also, the chronic cases that have already been examined are showing satisfactory results. In one case, there was another operative intervention to reposition a dislocated LV lead. The complications that appeared in the other three cases were recognized in the follow-up examination and were remedied by reprogramming the pacemaker or ICD.

The demonstrated decrease of the QRS-width with biventricular stimulation indicates a successful correc-

tion of the interventricular conduction disturbances and possibly an improvement in cardiac function. However, clinical parameters in chronic cases must still be raised in order to be able to describe the success of resynchronization therapy.

The recently developed Corox LV-H lead showed excellent characteristics during both positioning and fixation. In chronic cases, a dislocation was not observed in any of the 16 implanted leads.

### Conclusion

The first observed results of BEATLE show that the implantation of a biventricular resynchronization system by Biotronik compared with other systems found on the market is just as safe and successful.

### References

- [1] Garg R, Packer M, Pitt B, et al. Heart failure in the 1990s: Evaluation of a major public health problem in cardiovascular medicine. *J Am Coll Cardiol.* 1993; 22 (Suppl A): 3A-5A.
- [2] Krumholz HM, Chen YT, Wang Y, et al. Predictors of readmission among elderly survivors of admission with heart failure. *Am Heart J.* 2000; 139: 72-77.
- [3] Farwell D, Patel NR, Hall A, et al. How many people with heart failure are appropriate for biventricular resynchronization? *Eur Heart J.* 2000; 21: 246-250.
- [4] Xiao HB, Brecker SJ, Gibson DG. Effects of abnormal activation on the time course of the left ventricular pressure pulse in dilated cardiomyopathy. *Br Heart J.* 1992; 68: 403-407.
- [5] Littmann L, Symasnski JD. Hemodynamic implications of left bundle branch block. *J Electrocardiol.* 2000; 33 (Suppl): 115-121.
- [6] Saxon LA, Kerwin WF, Cahalan MK, et al. Acute effects of intraoperative multisite ventricular pacing on left ventricular function and activation/contraction sequence in patients with depressed ventricular function. *J Cardiovasc Electrophysiol.* 1998; 9: 12-21.
- [7] Kerwin WF, Botvinick EH, O'Connell JW, et al. Ventricular contraction abnormalities in dilated cardiomyopathy: effect of biventricular pacing to correct interventricular dyssynchrony. *J Am Coll Cardiol.* 2000; 35: 1221-1227.
- [8] Auricchio A, Stellbrink C, Block M, et al. Effect of pacing chamber and atrioventricular delay on acute systolic function of paced patients with congestive heart failure. *Circulation* 1999; 99: 2993-3001.
- [9] Cazeau S, Leclercq C, Lavergne T, et al. Effects of multisite biventricular pacing in patients with heart failure and intraventricular conduction delay. *N Engl J Med.* 2001; 344: 873-880.
- [10] Etienne Y, Mansourati J, Touiza A et al. Evaluation of left ventricular function and mitral regurgitation during left ventricular-based pacing in patients with heart failure. *Eur J Heart Fail.* 2001; 3: 441-447.
- [11] Gras D, Mabo P, Tang T, et al. Multisite pacing as a supplemental treatment of congestive heart failure: preliminary results of the Medtronic Inc. InSync Study. *PACE.* 1998; 21: 2249-2255.
- [12] Kass DA, Chen CH, Curry C, et al. Improved left ventricular mechanics from acute VDD pacing in patients with dilated cardiomyopathy and ventricular conduction delay. *Circulation.* 1999; 99: 1567-1573.
- [13] Lau CP, Yu CM, Chau E, et al. Reversal of left ventricular remodeling by synchronous biventricular pacing in heart failure. *PACE.* 2000; 23: 1722-1725.
- [14] Leclercq C, Cazeau S, Le Breton H, et al. Acute hemodynamic effects of biventricular DDD pacing in patients with end-stage heart failure. *J Am Coll Cardiol.* 1998; 32: 1825-1831.
- [15] Leclercq C, Cazeau S, Ritter P, et al. A pilot experience with permanent biventricular pacing to treat advanced heart failure. *Am Heart J.* 2000; 140: 862-870.
- [16] Braunschweig F, Linde C, Gadler F, et al. Reduction of hospital days by biventricular pacing. *Eur J Heart Fail.* 2000; 2: 399-406.
- [17] Ricci R, Ansalone G, Toscano S, et al. Cardiac resynchronization: materials, technique and results. The Insync Italian Registry. *Eur Heart J.* 2000; 2 (Suppl): J6-J15.

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