

## Feasibility evaluation of dual axis rotational angiography (XperSwing) in the diagnosis of coronary artery disease

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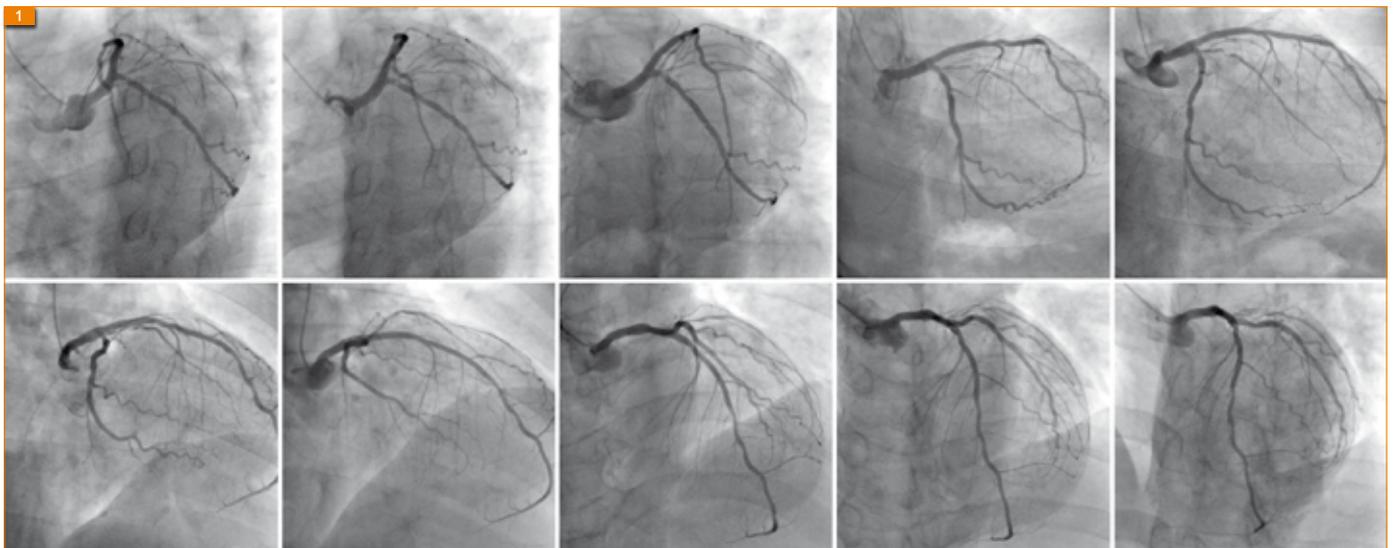
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During coronary angiography, the use of potentially harmful X-ray radiation and iodine contrast agent should be kept to a minimum, without compromising the diagnostic accuracy of the procedure. Coronary angiography is conventionally performed in multiple stationary views at different angles around the patient. A complete X-ray run with contrast injection is made in each view. An alternative to stationary views is rotational angiography, in which the X-ray system rotates around the patient during the acquisition of a single run. Rotational angiography can provide a significant reduction in both contrast agent usage and radiation dose of up to 30%, without compromising the clinical utility of the images [1-2].

The rotations are made around a single axis in a single plane and usually two rotations are needed to image the left coronary artery (LCA) and one rotation for the right coronary artery (RCA). In addition, some static views are made at the discretion of the physician to obtain additional views, since single axis rotations are limited in their ability to cover all desired anatomical views in a single rotation. Recently, a new technique of dual axis rotational coronary angiography has been developed called XperSwing (Philips Healthcare, Best, the Netherlands). During dual axis rotations the system rotates with curved trajectories around the patient, thereby allowing imaging in all desired anatomical views in a single run (Figure 1). The trajectories are pre-programmed and are optimized to maximize the clinical image content, while staying within safe boundaries in order to avoid any collisions. Dedicated trajectories are available for the left and the right coronary arteries (Figure 2).



▲  
Figure 1. Ten images selected from a single dual axis rotation acquisition of the left coronary artery (LCA). A wide range of views of the coronary are obtained with a single contrast agent injection.

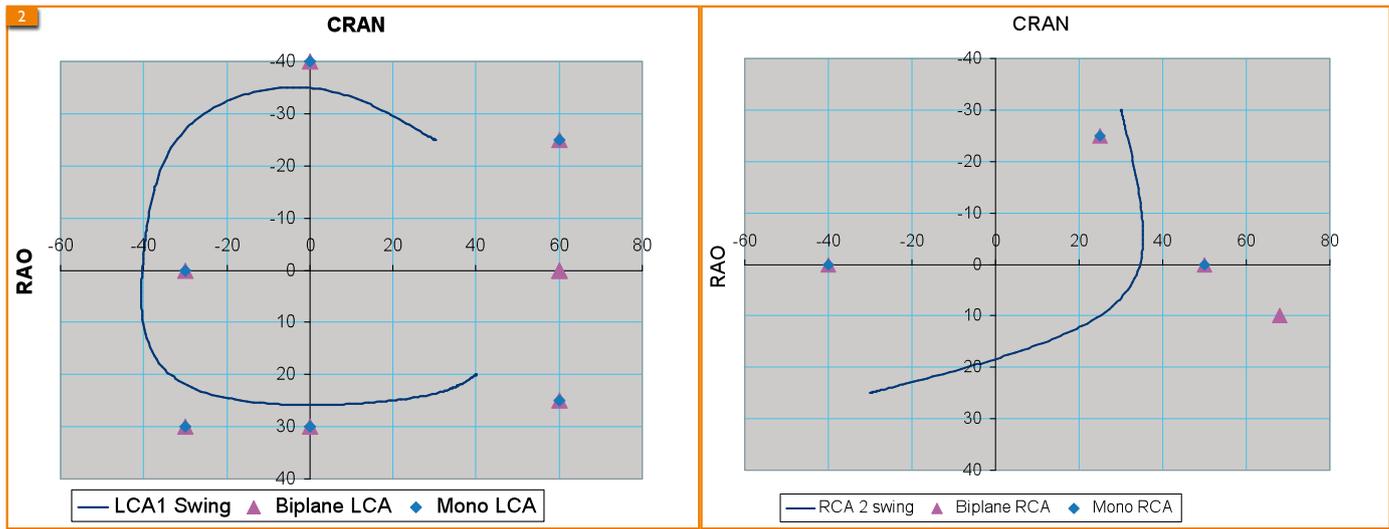


Figure 2. Standard views (marked with pink triangles) and dual axis trajectories (marked with blue lines) for coronary angiography of the left coronary artery (LCA) (left panel) and the right coronary artery (RCA) (right panel).

In this article the intermediate results of an ongoing study investigating the effect of XperSwing on contrast and radiation dose utilization are reported. Contrast utilization and radiation dosage of XperSwing were compared to conventional biplane coronary angiography (standard angiography). In addition, the procedure times for XperSwing and standard angiography were evaluated.

### Materials and methods

A total of twenty-six patients undergoing diagnostic coronary angiography were randomized to either standard angiography (n = 13) or XperSwing angiography (n = 13). All acquisitions were performed on a biplane flat-panel detector system (Allura Xper FD10/10, Philips Healthcare, Best, the Netherlands). For this evaluation the system was equipped with the prototype option of XperSwing.

For the standard angiography group, the pre-specified protocol used six projections for the LCA and three projections for the RCA. Biplane acquisitions were obtained simultaneously for all projections of the LCA and for one projection of the RCA. A monoplane acquisition was obtained for the second run of the RCA. The injector setting for maximum contrast flow was 3.5 mL/second (total 7 mL) for the LCA and 2.5 mL/second (total 5 mL) for the RCA.

For the XperSwing angiography group one dual axis rotational angiography was made for the LCA and one dual axis rotational angiography for the RCA. The XperSwing trajectories used can

be found in Figure 1. The injector settings for maximum contrast flow were 2.5 mL/second (total 17.5 mL) for the LCA and 2.0 mL/second (total 7 mL) for the RCA.

If the diagnostic information from either the standard or XperSwing group was deemed insufficient, additional images could be taken. The necessity of this additional run was judged by the operating cardiologist. Any additional runs were acquired in monoplane. Both the protocol images, plus any additional images, were included in the final data analysis.

For both patient groups, total contrast agent utilization, patient radiation dose and angiographic procedure time were evaluated. The contrast agent utilization was recorded in mL, the patient radiation dose was recorded using the internal dose meter of the X-ray system (dose area product in Gy<sub>cm</sub><sup>2</sup>) and the procedure time was measured between engaging the coronary ostium and the moment when the cardiologist determined that a diagnostic study had been completed. The time needed to review the acquired angiographic runs was included in the procedure time.

Patients who had prior angiography, acute coronary syndrome, serum creatinine <sup>3</sup> 1.5 mg/dL or suspicion of vasospastic angina were excluded. All catheterizations were performed using a 4-french catheter. After intra-coronary nitroglycerin injection, angiography of the LCA was first performed, followed by the RCA. All injections were performed with an auto-inject system (ACIST). All operators were experienced with rotational scanning.

## Results

As is dictated by the site protocol for acquiring images (Figure 3), the number of angiographic runs (9 runs) in the standard group was substantially higher than in the XperSwing group (3 runs). For four out of 13 (31%) of the XperSwing patients, additional (steeper) views were needed in order to better visualize the left main trunk bifurcation. The total number of runs required in order to achieve adequate diagnosis was on average 9.1 runs for the standard group and 3.5 runs for the XperSwing group.

There was no significant difference in procedure time between the standard group (3 min. 24 seconds) and the XperSwing group (3 min. 28 seconds).

The average contrast utilization for a procedure (Figure 4) was also significantly ( $p < 0.05$ ) higher for standard angiography (33.5 mL) compared to that necessary for XperSwing angiography (27.2 mL). Similarly, the X-ray dose required (Figure 5) for standard angiography (56 Gy<sub>cm</sub><sup>2</sup>) was significantly higher than that required for XperSwing angiography (27 Gy<sub>cm</sub><sup>2</sup>).

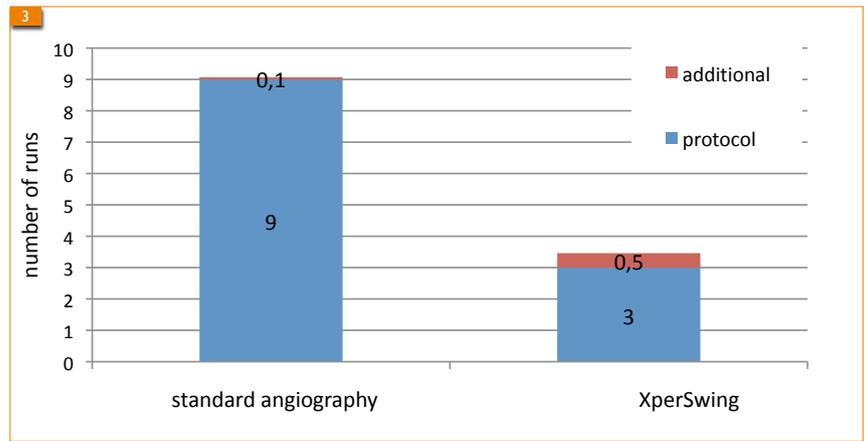


Figure 3. Average number of angiographic runs for the standard angiography (n = 13) versus the XperSwing rotational angiography (n = 13) groups.

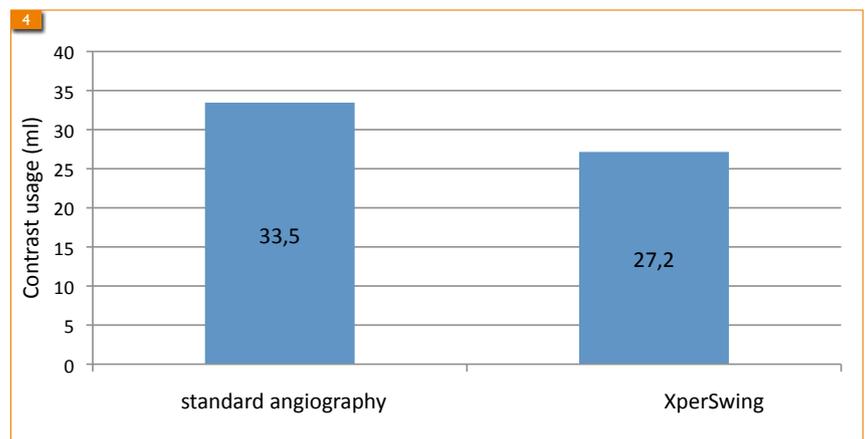


Figure 4. Contrast agent utilization in milliliters (mL) for the standard angiography (n = 13) versus the XperSwing rotational angiography (n = 13) groups.

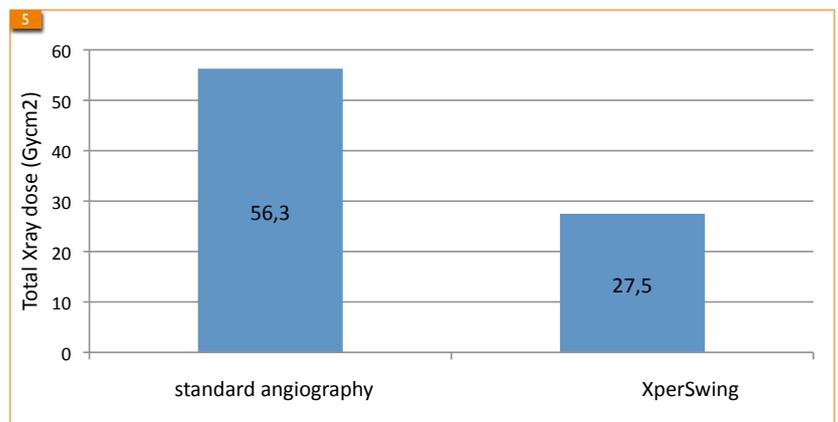


Figure 5. Dose area product (DAP), a measure of total radiation exposure, in Gy<sub>cm</sub><sup>2</sup> for the standard angiography (n = 13) versus the XperSwing rotational angiography (n = 13) groups.

## Conclusions

The preliminary results of this study, comparing standard angiography with XperSwing angiography, shows the potential of XperSwing to reduce both contrast agent usage and radiation dose. In 69% of patients XperSwing provided complete and sufficient information for the diagnosis as judged by the primary operator. In the remaining 31% of XperSwing patients one or more additional static views were performed to properly diagnose the LTM bifurcation. These additional views were taken into account with the X-ray dose and contrast load savings.

XperSwing rotational angiography is a promising technique for the reduction of contrast agent and X-ray dose in diagnostic coronary angiography. Contrast reduction is especially beneficial for patients with increased risk of renal insufficiency. Additional studies are needed to assess diagnostic accuracy and verify the contrast and dose reduction. ■

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