

Clinical quick guide

The journey to fluoro free



DART™
Direct Anterior
Reconstructive Technology

Why consider joining the **journey to fluoro free**?

Intraoperative radiation exposure is associated with unwanted side effects, such as cancer.^{1,2} **Protective lead gear (PLG)** can become less effective over time³ and have been linked to several unintended side effects such as back pain⁴ and potential bacterial contamination in the OR.⁵ Additionally, **two-dimensional images** produced by fluoroscopy may not lead to better positioning of the components.⁶⁻⁸

Intraoperative radiation

Surgeons and OR staff may be exposed to ionizing radiation during direct anterior hip procedures. Exposure to radiation may increase the risk of unwanted side effects, including breast cancer,¹ thyroid cancer and cataracts.²

Reference	Detail	Link
1 Valone LC, Chambers M, Lattanza L, James MA. Breast Radiation Exposure in Female Orthopaedic Surgeons. J Bone Joint Surg Am. 2016 Nov 2;98(21):1808-1813. doi: 10.2106/JBJS.15.01167. PMID: 27807113	This study used a female torso phantom with radiation dosimeters attached to measure radiation exposure to the Upper Outer Quadrant (UOQ) and Lower Inner Quadrant (LIQ) of the breast. Radiation dose was measured during fluoroscopy with different surgeon positions and sizes and styles of lead apron. Breast radiation exposure was higher in a C-arm lateral projection compared with an anteroposterior projection. Higher doses were observed for the UOQ compared with the LIQ of the breast and for aprons that were too small or too large.	 Click or scan to read more
2 Daryoush JR, Lancaster AJ, Frandsen JJ, Gililand JM. Occupational Hazards to the Joint Replacement Surgeon: Radiation Exposure. J Arthroplasty. 2022 Aug;37(8):1464-1469.	This study reviews the amount of radiation exposure in orthopaedic surgery and the potential health risks associated with exposure. While episodic exposure is low and within safe procedural limits. The authors conclude that the stochastic effect of life-long cumulative radiation exposure means that protective measures are imperative.	 Click or scan to read more

Protective lead gear

Traditionally, surgeons and their OR staff use protective lead gear (PLG) to minimize radiation exposure. However, PLG can become less effective over time,³ may not completely cover the whole breast area in female surgeons¹ and may be associated with unintended side effects such as back pain.⁴ Additionally, a study has shown that PLG are a potential source of bacterial contamination in the OR.⁵

Reference	Detail	Link
3 Kellens PJ, De Hauwere A, Gossye T, et al. Integrity of personal radiation protective equipment (PRPE): a 4-year longitudinal follow-up study. <i>Insights Imaging</i> . 2022;13(1):183	This study evaluated 1011 PLGs over a four-year period. In total, 47.3% of the PLG showed tears of which 31% exceeded rejection criteria. Remarkably, of 287 new pieces of PLG, 6.0% showed tears in the first year of use of which 88.2% needed to be rejected. The authors conclude that regular X-ray-based integrity analysis of PRPE is needed to ensure adequate radioprotection for staff exposed to ionizing radiation.	 Click or scan to read more
4 Andrew S, Abdelmonem MR, Kohli S, Dabke H. Evaluation of Back Pain and Lead Apron Use Among Staff at a District General Hospital. <i>Cureus</i> . 2021;13(10):e18859.	Questionnaire study of staff in departments with high PLG use compared to staff in departments with low use. High use was defined as use on two or more days every week. The prevalence of back pain was higher in the group with high PLG use (63%) compared to the low use group (32%). Of staff who experienced back pain in the high use group, 83% attributed it to lead apron use, compared to 37% in the low use group.	 Click or scan to read more
5 Gilat R, Mitchnik I, Beit Ner E, Shohat N, Tamir E, Weil YA, Lazarovitch T, Agar G. Bacterial contamination of protective lead garments in an operating room setting. <i>J Infect Prev</i> . 2020 Nov;21(6):234-240.	Swab samples were taken from 20 body PLGs and 21 neck PLGs. Of all PLGs, 87.8% were contaminated with bacteria commonly associated with surgical site infections and prosthetic joint infections. The most common organism was <i>Staphylococcus epidermidis</i> ($P = 0.048$). The neck-thyroid shield PLGs was more contaminated than body apron. Since neck PLGs are often directly exposed above the surgical sterile gown this finding is described as concerning.	 Click or scan to read more

Two-dimensional images

Surgeon estimation of acetabular orientation on two-dimensional images may be unreliable.^{6,7} Additionally, the position of the imaging equipment has been shown to impact the accuracy of the images produced.⁸

Reference	Detail	Link
6 Brush PL, Santana A, Toci GR, et al. Surgeon Estimations of Acetabular Cup Orientation Using Intraoperative Fluoroscopic Imaging Are Unreliable. Arthroplasty Today. 2023;20:101109.	Thirty-four surgeons were asked to estimate acetabular component inclination and anteversion based on 20 IF images of THA through a direct anterior approach. Surgeons surveyed were on average 5.9° away from the true value of inclination (SD = 4.7) and 8.8° away from the true value of anteversion (SD= 6.0). Respondents were within 5° of both inclination and anteversion in 19.7% of cases, and within 10° in 57.3% of cases.	 Click or scan to read more
7 James CR, Peterson BE, Crim JR, Cook JL, Crist BD. The Use of Fluoroscopy During Direct Anterior Hip Arthroplasty: Powerful or Misleading?. J Arthroplasty. 2018;33(6):1775-1779	Forty-one hips in 40 patients undergoing direct anterior THA with fluoroscopic assistance underwent routine postoperative radiographs and postoperative CT scans. The results showed that 39/41 hips were placed with unrecognized excess of anteversion and inclination secondary to imaging the pelvis in extension.	 Click or scan to read more
8 Thorne TJ, Wright AR, Opanova MI, et al. Impact of intraoperative fluoroscopic beam positioning relative to the hip and pelvis on perceived acetabular component position. J Orthop. 2022;35:115-119.	Fluoroscopic images were taken of a pelvis model at a variety of angles. The authors found that the projected image of the acetabular component changed dramatically depending on fluoroscopic beam position relative to the hip and pelvis.	 Click or scan to read more

The potential benefits of **Mako Total Hip** and **Direct Anterior Reconstructive Technology (DART™)**

Mako Total Hip and Direct Anterior Reconstructive Technology (DART™) has been shown in a lab-based study to eliminate the need for intraoperative fluoroscopy, **reducing radiation exposure** to the surgeon and OR staff.⁹ Furthermore, Mako Total Hip and DART™ have demonstrated **improved accuracy** to plan of cup positioning and centre of rotation in a clinical study.¹⁰ Additionally, a lab-based study has shown Mako Total Hip and DART™ to be associated with a **reduction in soft tissue damage** compared to fluoro-guided Direct Anterior THA.¹¹

Users in a lab-based study experienced **reduced physical and mental demand** during robotic THA as compared to manual.¹² Additionally, surgeons that use Mako Total Hip may benefit from efficiencies such as **reduced operating times and fewer instruments** compared to fluoroscopy-guided THA.^{13,14}

Reduced radiation exposure

A study of Direct Anterior Approach Total Hip Arthroplasty (DAA-THA) compared radiation exposure between Manual (M-THA), Computer-Assisted Navigated (CAN-THA) and Robotic-Arm Assisted (RA-THA) techniques. The use of RA-THA was associated with a six-fold reduction in Intra-operative radiation exposure in the OR compared to both M-THA and CAN-THA, reducing the radiation exposure to the patient, the surgeon and surgical staff.⁹

Reference	Detail	Link
9 Neitzke CC, Regis CJ, Bhatti P, et al. Robotic-Assisted Direct Anterior Approach Total Hip Arthroplasty: A 6.5-fold Reduction in Fluoroscopic Radiation Exposure. J Arthroplasty. 2025;40(7):1752-1757.e2.	A retrospective review of 6,541 patients undergoing primary Direct Anterior Total Hip Arthroplasty (DAA-THA) examined mean fluoroscopy time and radiation dose between surgery carried out with Robotic-Assistance (RA-THA), Computer Assisted Navigation (CAN-THA), or Manual (M-THA) techniques. The RA-THA cohort had a shorter mean fluoroscopy time (4.4 ± 5.6 seconds) than both the CAN-THA (17.6 ± 9.1 seconds, $P < 0.001$) and M-THA (21.8 ± 39.4 seconds, $P < 0.001$) groups. The RA-THA cohort had a smaller mean fluoroscopic radiation dose (0.4 ± 0.6 mGy) than both CAN-THA (2.6 ± 2.2 mGy, $P < 0.001$) and M-THA (2.5 ± 2.5 mGy, $P < 0.001$), this corresponded to a 6.5-fold reduction in radiation exposure in the operating room compared to both CAN-THA and M-THA. The authors conclude that adopting RA-THA could be a potential strategy to enhance operating room safety and mitigate the risk of radiation exposure.	 Click or scan to read more

Improved accuracy

Cup orientation and center of rotation accuracy have been shown to be improved with Mako Total Hip compared to fluoroscopic guidance in Direct Anterior Approach (DAA) THA.¹⁰

Reference	Detail	Link
10 Foissey C, Batailler C, Coulomb R, et al. Image-based robotic-assisted total hip arthroplasty through direct anterior approach allows a better orientation of the acetabular cup and a better restitution of the centre of rotation than a conventional procedure. <i>Int Orthop</i> . 2023;47(3):691-699	This retrospective study compared 100 manual Total Hip Arthroplasties (THA) to 50 Robotic-Arm Assisted THAs (RA-THA) carried out using Direct Anterior Approach (DAA). The RA-THA cups were better oriented with 98% in the global safe zone vs. 68% in the THA group ($p < 0.001$). The average Centre of Rotation (COR) was better restored in the robotic group in the horizontal and vertical planes (Δ HCOR = -5.0 ± 5.0 vs -3.4 ± 4.9 , $p = 0.03$; Δ VCOR = 1.6 ± 3.3 vs 0.2 ± 2.7 , $p = 0.04$). There were fewer outliers in the RATHA group concerning VCOR (28% versus 10%, $p = 0.03$).	 Click or scan to read more

Reduction in soft tissue damage

Damage to the gluteus minimus, sartorius, tensor fascia lata and vastus lateralis muscle has been shown to be lower during Direct Anterior approach THA with Mako Total Hip than when using free-hand reamers in a lab-based study.¹¹

Reference	Detail	Link
11 Hampp EL, Caba M, Scholl L, Faizan A, Frye BM, Nessler JP, Sequeira SB, Mont MA. Can Robotic-Arm Assistance Decrease Iatrogenic Soft-Tissue Damage During Direct Anterior Total Hip Arthroplasty? <i>Surg Technol Int</i> . 2024 Mar 1;44:sti44/1761. PMID: 38442246	This cadaveric study compared the soft tissue damage in 6 fresh frozen cadavers, with two surgeons performing 3 manual THAs and 3 RATHAs. Analysis of the gluteus minimus, sartorius, tensor fascia lata, and vastus lateralis muscles demonstrated that the RA-THA specimens underwent less damage to these structures than the MTHA group (median, IQR: 1.0, 1.0 to 2.0 vs. 3.0, 2.0 to 3.0; $p = 0.003$). Analysis of the calculated volumetric damage (mm^3) for the gluteus minimus, sartorius, tensor fascia lata, and vastus lateralis muscles demonstrated that the cadaver specimens that underwent RTHA underwent less damage to these structures than those that followed MTHA (median, IQR: 23, 2 to 586 vs. 216, 58 to 3,050; $p = 0.037$).	 Click or scan to read more

Reduced physical and mental demand

Surgeons in a lab-based study were shown to operate closer to normal levels of physiological stress such as blood pressure, heart rate and heart rate variability when using Mako Total Hip than when using fluoroscopy while performing the Direct Anterior approach THA.¹²

Reference	Detail	Link
12 Caba M, Gains C, Nessler J, Frye B, Scholl L, Sequeira SB, Mont M, Physical and Mental Demand During Direct Anterior Total Hip Arthroplasty: Comparison of Robotic-Assisted and Conventional Techniques. J. Ortho. doi.org/10.1016/j.jor.2024.07.001.	Two orthopaedic surgeons completed bilateral DA THAs on six cadaveric specimens, performing 3 manual THAs and 3 RA-THAs. Physical and mental demand was measured using heart rates (HR), respirations, HR variability (stress), calories and sweat loss as well as a validated questionnaire. Physical and mental demand was lower in RA-THA without fluoroscopy. Robotic-assisted THA was associated with a decreased percentage change for both the overall procedure and all surgical steps. Robotic-assisted THA also resulted in a significant difference in percentage change for maximum HR during acetabular reaming.	 Click or scan to read more

Reduced operative times and fewer instruments

A lab-based study has shown that surgeons using Mako Total Hip were able to reduce reaming time and instrumentation use through single-stage reaming when carrying out Direct Anterior THA.¹³ In addition, another study outlines the efficiency and reduction of surgical time with Mako Total Hip.¹⁴

Reference	Detail	Link
13 Caba M, O'Neill C, Nessler J, Frye B, Scholl L, Sequeira SB, Mont M. Robotic Assistance is Associated with Improved Surgical Efficiency During Direct Anterior Total Hip Arthroplasty, J Ortho. doi.org/10.1016/j.jor.2024.06.027.	This cadaveric study assessed manual fluoroscopy and Robotic-Arm Assisted THA on contralateral DAA THAs on the same specimen. Acetabular reaming took longer for the fluoroscopy group than RA-THA without fluoroscopy (2.4 ± 0.6 vs. 0.4 ± 0.2 min; $p < 0.001$). Surgeons using fluoroscopy required more acetabular reamers compared to a single reamer used with RA-THA (2.67 ± 0.5 versus 1 ± 0 ; $p = 0.001$). Total operative time, acetabular workflow time, femoral workflow time and number of femoral broaches were higher during manual THA than RA-THA.	 Click or scan to read more

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The journey to fluoro free | **Part II****Reduced operative times and fewer instruments (continued)**

Reference	Detail	Link
14 Nessler J, Stephanie C, Barga K, Coppolecchia A. Robotic-Arm Assisted Total Hip Arthroplasty: Workflow Optimization and Operative Times. Surg Technol Int. Published online November 30, 2023. doi:10.52198/23.STI.43. OS1708	This paper lays out a process to help achieve an optimal RA-THA workflow and efficiencies in an ambulatory surgery center and presents timing data from 105 cases.	 Click or scan to read more

A surgeon must always rely on his or her own professional clinical judgment when deciding whether to use a particular product when treating a particular patient. Stryker does not dispense medical advice and recommends that surgeons be trained in the use of any particular product before using it in surgery.

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