The posture matrices of the pelvic and cup coordinate systems relative to the world coordinate system were obtained from JointTrack (University of Florida, Gainesville, Florida, USA) (R_p and R_c).

$$R_p = \begin{bmatrix} \alpha_1 & \alpha_2 & \alpha_3 \\ \beta_1 & \beta_2 & \beta_3 \\ \gamma_1 & \gamma_2 & \gamma_3 \end{bmatrix}, \quad R_c = \begin{bmatrix} \lambda_1 & \lambda_2 & \lambda_3 \\ \mu_1 & \mu_2 & \mu_3 \\ \nu_1 & \nu_2 & \nu_3 \end{bmatrix}$$

The posture matrix of the cup coordinate systems relative to the pelvic coordinate system (R_{c2}) was calculated as follows:

$$R_{c2} = R_p^T R_c = \begin{bmatrix} \lambda'_1 & \lambda'_2 & \lambda'_3 \\ \mu'_1 & \mu'_2 & \mu'_3 \\ \nu'_1 & \nu'_2 & \nu'_3 \end{bmatrix}$$

The normal vector of the cup opening plane was calculated as:

$$(\mu'_2\nu'_3 - \nu'_2\mu'_3 \quad \nu'_2\lambda'_3 - \lambda'_2\nu'_3 \quad \lambda'_2\mu'_3 - \mu'_2\lambda'_3)$$

Therefore, the radiological anteversion angle (RA) and radiological inclination angle (RI) were calculated from these expressions.

$$\cos\theta_{RA} = \frac{|\lambda'_2\mu'_3 - \mu'_2\lambda'_3|}{\sqrt{(\nu'_2\lambda'_3 - \lambda'_2\nu'_3)^2 + (\lambda'_2\mu'_3 - \mu'_2\lambda'_3)^2}}$$

$$\sin\theta_{RI} = \frac{|\mu'_2\nu'_3 - \nu'_2\mu'_3|}{\sqrt{(\mu'_2\nu'_3 - \nu'_2\mu'_3)^2 + (\nu'_2\lambda'_3 - \lambda'_2\nu'_3)^2}}$$