



## Surgical technique

## A Novel Method of Determining Acetabular Component Size to Guide Explant in Revision Hip Arthroplasty

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## ABSTRACT

Revision hip arthroplasty is a frequently performed procedure and is projected to increase annually. Removal of a well-fixed acetabular component can involve loss of much needed bone stock. Contemporary instruments allow acetabular removal with minimal morbidity; however, their use requires accurate knowledge of the component size. We describe a technique that allows sizing to be determined accurately, without specialized equipment, in situations where component details are unavailable. Our technique multiplies ratio of head:cup on pre-operative X-ray by the diameter of the index femoral head which is removed intra-operatively to predict index cup size. This novel surgical technique appears accurate in prediction of cup size to guide explant in revision hip arthroplasty.

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## Introduction

Hip replacement is one of the most common orthopedic surgeries with 49,764 hip replacements carried out in Australia in 2018. Revision hip replacements are reoperations in which one or more of the prosthetic components are replaced or removed and accounted for 8.3% of all hip replacements in 2018 [1].

Removal of the acetabular cup is challenging and can be associated with prolonged operative time and complications [2]. The excessive bone loss associated with removal of a well-fixed cup can make implantation of a revision cup difficult [3]. Traditional

instruments such as the Aufranc gouges used for this purpose have been replaced with explant equipment such as the Zimmer Explant Acetabular Cup Removal System (Zimmer Biomet, Warsaw, IN) and Innomed Extraction System (Innomed Inc., Savannah, GA). These systems remove the cup with less bone loss but require knowledge of the diameter of the existing cup [4,5]. Radiographic templating is used preoperatively to predict component size, but inaccuracies due to scale and magnification errors are common [6-13]. Details of the index prosthesis from the medical records are highly valuable information but are not always available at the time of revision surgery because of case urgency, patient migration, clerical error, or destruction of records.

We developed a novel surgical technique that overcomes the issue of missing component information and templating inaccuracy and can be used to guide acetabular cup sizing in revision hip replacement surgery. The femoral head and the acetabular shell are placed concentrically and will therefore both be magnified a similar amount on radiograph. This allows us to calculate a ratio of cup/

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head size. While the measured sizes may not be accurate, the ratio will be. The technique is similar to that described by Krishnamoorthy et al. [14] and uses a ratio of cup:head diameter from one digital Charnley Pelvis anteroposterior radiograph (Cxr/Hxr). This ratio is then multiplied by an object of known diameter to give a predicted cup value for the revision cup. In our technique, the known diameter object is the femoral head which is removed intraoperatively during the revision surgery (Hop). We have found that the calculation ( $Cxr/Hxr \times Hop$ ) can be performed quickly and easily intraoperatively to accurately predict acetabular cup size.

This study aims to describe a technique to accurately predict index cup size in the absence of operation reports in revision hip arthroplasty.

### Surgical technique

Preoperative radiographs are reviewed as part of the planning for revision hip arthroplasty surgery. The diameter of the acetabular cup (Cxr) and diameter of femoral head (Hxr) are measured. In our practice, digital imaging programs were used, but this technique could also be applied to Acetate film radiographs. Measurements were made using the Charnley Anteroposterior view. Figure 1 shows measurement of diameters using a digital imaging software program.

A ratio of cup:head is calculated. This ratio is then multiplied by the actual diameter of the index femoral head when it is removed and measured intraoperatively to give a predicted cup size value. The formula  $Cxr/Hxr \times Hop$  gives predicted cup size (Cpred).

We write this formula on the board in the operating theater along with our standard templating measurements before scrubbing. We use the formula to calculate 3 possible cup sizes based on the common head sizes of 28 mm, 32 mm, and 36 mm. When the index femoral head is removed and measured, the surgeon consults the whiteboard to immediately find the corresponding cup diameter.

### Discussion

Removing a well-fixed acetabular cup can be a challenging step in revision hip replacement surgery. Excessive bone loss or fracture

of the acetabulum can compromise the fixation of a revision component [15–17]. Newer explant devices are available for the purpose of removal of a well-fixed acetabular cup while preventing excessive bone loss; however, knowledge of the size of the index cup is necessary to select the correct size explant device [18]. While this information is usually obtained from operative reports, such things as case urgency, patient migration, record destruction, or clerical error may mean that it is not available.

As part of our preoperative templating, we calculate 3 predicted cup sizes as described. We consult this precalculated formula intraoperatively to immediately find the acetabular cup value which corresponds to the measured head size. We have found that this allows us to have the correctly-sized explant equipment available immediately in cases in which previous implant records or operative reports are unavailable.

The strength of this technique is its ease and simplicity. The materials needed are inexpensive and can be applied in most settings worldwide [19]. This step is easy to perform in addition to the standard preoperative templating measurements [9,20]. Knowledge of the correct size of acetabular cup can save time and decrease intraoperative complications by having the correct explant blade size selected and available to the surgeon without delay [17,18,21].

The main weakness of this technique is that it has yet to be put to widespread clinical use. We have found the formula accurate in determining the size of the existing cup; however a prospective study is required to validate the accuracy of our formula.

### Summary

Use of this technique and formula for predicting acetabular cup size based on preoperative radiographs and measurement of the femoral head intra-operatively has the potential to reduce operating time and to decrease the risk of complications during revision hip arthroplasty surgery. It is simple and widely available to most surgeons. Prospective data is needed to validate this method, which appears to be effective in our practice.

### Conflict of interests

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

### References

- [1] Raves S, Davidson D, de Steiger RN. Australian Orthopaedic Association National Joint Replacement Registry (AOANJRR). Hip, Knee & Shoulder Arthroplasty: 2019 Annual Report. Adelaide: AOA; 2019. <https://aoanjrr.sahmri.com/annual-reports-2019>.
- [2] Goldberg VM. Revision of failure acetabular components with cementless acetabular components. *Am J Orthop (Belle Mead NJ)* 2002;31(4):206.
- [3] Geerdink CH, Schaafsma J, Meyers WG, Grimm B, Tonino AJ. Cementless hemispheric hydroxyapatite-coated sockets for acetabular revision. *J Arthroplasty* 2007;22(3):369.
- [4] Preiss RA, Patil S, Meek RM. The use of modular femoral head trials to centre the explant blade facilitates retrieval of well-fixed acetabular components with minimal bone loss. *Arch Orthop Trauma Surg* 2011;131(7):1003.
- [5] Rawal JS, Soler JA, Rhee JS, Dobson MH, Konan S, Haddad FS. Modification of the explant system for the removal of well fixed hip resurfacing sockets. *J Arthroplasty* 2010;25(7):1170.e7.
- [6] Archibeck MJ, Cummins T, Tripuraneni KR, et al. Inaccuracies in the use of magnification markers in digital hip radiographs. *Clin Orthop Relat Res* 2016;474(8):1812.
- [7] Kosashvili Y, Backstein D, Safir O, Ran Y, Loebenberg MI, Ziv YB. Digital versus conventional templating techniques in preoperative planning for total hip arthroplasty. *Can J Surg* 2009;52(1):6.
- [8] Marcucci M, Indelli PF, Latella L, Poli P, King D. A multimodal approach in total hip arthroplasty preoperative templating. *Skeletal Radiol* 2013;42(9):1287.

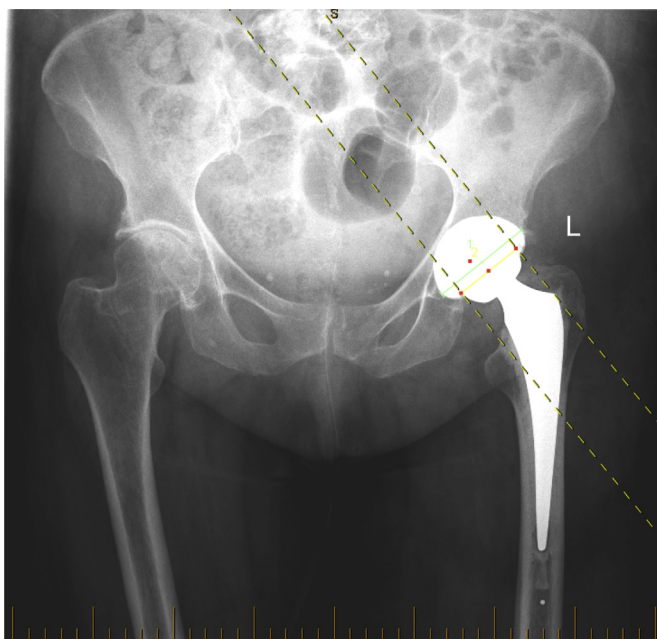


Figure 1. Measurement of component diameter using digital radiographs.

- [9] Meyer C, Kotecha A, Richards O, Isbister E. Acetate templating for total hip arthroplasty using PACS. *Ann R Coll Surg Engl* 2009;91(2):162.
- [10] Ranjitkar S, Prakash D, Prakash R. Magnification error of digital x rays on the computer screen. *Nepal Med Coll J* 2014;16(2–4):182.
- [11] Riddick A, Smith A, Thomas DP. Accuracy of preoperative templating in total hip arthroplasty. *J Orthop Surg (Hong Kong)* 2014;22(2):173.
- [12] Ries MD. CORR Insights®: acetate templating on digital images is more accurate than computer-based templating for total hip arthroplasty. *Clin Orthop Relat Res* 2015;473(12):3760.
- [13] Shin JK, Son SM, Kim TW, Shin WC, Lee JS, Suh KT. Accuracy and reliability of preoperative on-screen templating using digital radiographs for total hip arthroplasty. *Hip Pelvis* 2016;28(4):201.
- [14] Krishnamoorthy VP, Perumal R, Daniel AJ, Poonnoose PM. Accuracy of templating the acetabular cup size in Total Hip Replacement using conventional acetate templates on digital radiographs. *J Clin Orthop Trauma* 2015;6(4):215.
- [15] Hall A, Eilers M, Hansen R, et al. Advances in acetabular reconstruction in revision total hip arthroplasty: maximizing function and outcomes after treatment of periacetabular osteolysis around the well-fixed shell. *Instr Course Lect* 2014;63:209.
- [16] Olyslaegers C, Wainwright T, Middleton RG. A novel technique for the removal of well-fixed cementless, large-diameter metal-on-metal acetabular components. *J Arthroplasty* 2008;23(7):1071.
- [17] Paprosky WG, Weeden SH, Bowling JW. Component removal in revision total hip arthroplasty. *Clin Orthop Relat Res* 2001;(393):181.
- [18] Adelani MA, Goodman SB, Maloney WJ, Huddleston 3rd JI. Removal of well-fixed cementless acetabular components in revision total hip arthroplasty. *Orthopedics* 2016;39(2):e280.
- [19] Barrack RL. Preoperative planning for revision total hip arthroplasty. *Clin Orthop Relat Res* 2004;(420):32.
- [20] Bono JV. Digital templating in total hip arthroplasty. *J Bone Joint Surg Am* 2004;86-A(Suppl 2):118.
- [21] Markovich GD, Banks SA, Hodge WA. A new technique for removing non-cemented acetabular components in revision total hip arthroplasty. *Am J Orthop (Belle Mead NJ)* 1999;28(1):35.