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Case Report

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Minimum 5-Year Follow Up of Porous Coated Cementless Total Hip Arthroplasty

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Abstract

Older generation cementless stems had a high incidence of thigh pain and stress shielding, and created difficult revisions. Modern cementless total hip arthroplasties have addressed these concerns with a series of design changes. This study evaluated follow up data from 100 consecutive cementless total hip arthroplasties. Physical exams and radiographic evaluation were performed and Harris Hip Scores (HHS)were documented at final follow up with an average of 89 (range from 71-100). Low complication rates were observed; five-year survivorship of the stem was 100% while survivorship of the cup was 99%. Cementless total hip arthroplasties remain a viable option with excellent HHS, low revision rates, and zero incidence of thigh pain or aseptic loosening in our current study.

Keywords: Cementless Total Hip Arthroplasty; Harris Hip Score; Klassic HD; Ongrowth; Ti-Coat; Total Hip Arthroplasty; Total Joint Orthopedics; Zweymuller

Introduction

Cemented Total Hip Arthroplasty (THA) has become less frequent as surgeons have most turned their attention to cementless fixation. The success of cementless fixation depends on the surgeon's ability to correctly identify proximal femoral geometry and appropriately contour the bone to accept the cementless implant [1]. Due to aseptic loosening causing failure of cemented stems, particularly in younger patients [2,3], there has been a large increase in the use of cementless femoral stems in total hip arthroplasty. First generation cementless stems showed a high incidence of thigh pain, stress shielding, and difficult revisions [4,5], thus newer generations of cementless stems were designed with proximal porous coating, and a more pronounced taper in order to decrease thigh pain and accommodate proximal loading, which limits stress shielding. Titanium alloys, which more closely mimic the physiological stress of native bone, and have predominantly replaced the more rigid cobalt chrome alloys that were previously used. The purpose of this study is to evaluate Harris Hip Scores (HHS) at 5 years follow up in 100 consecutive total hip arthroplasties.

Materials and Methods

Implant Design

Total Joint Orthopedic, Inc.'s Klassic HD® (Figure 1) stem is a double-wedge Zweymuller-type stem made of titanium alloy to decrease stiffness and more closely resemble native cortical bone. The proximal portion of the stem features Ti-Coat,® a three-dimensional rough titanium ultra-porous coating (>60% porosity), which allows for bony in-growth; the mid-stem has a grit-blasted finish along the femoral shaft for bony on growth, and the distal tip is polished to reduce stress shielding. The prosthesis is nonmodular, and comes in standard or high offset stem options, providing a both 121- and 131- degree neck shaft angle constructs. Femoral stems are collarless to allow for a full press fit as well as ease of removal, and sizes range from 1-9 (110-150 mm in length) with a 2.5 mm femoral neck length increase after every third femoral stem size. All stems feature a 12/14 neck taper and were used with a 32 or 36 mm cobalt chrome femoral head. The titanium acetabular cups offer a hemispherical design with Ti-Coat ultra-porous coating for cementless fixation; available sizes range from 44-64 mm. Fixation was augmented in all cases with the use of cancellous bone screws. Acetabular inserts are a standard flat-faced design made of highly cross linked polyethelene.

Figure 1: Klassic HD Hip System. Courtesy of Total Joint Orthopedics, Inc.

Study Design

Follow up data of 100 consecutive total hip arthroplasties performed in 2013 and 2014 was obtained via chart and radiographic review, personal physical exam and/or telephone collection of HHSs. Indications for surgery were: post-traumatic osteoarthritis (three patients); painful developmental hip dysplasia, Crowe Type 3(one patient) and Crowe type 4 (two patients) [6]; and osteoarthritis. A posterior lateral approach was performed in all cases by the senior author (AAH). A 32 mm or 36 mm femoral head was used in all cases. All patients received a Total Joint Orthopedics, Inc (Salt Lake City, Utah) Klassic HD® cementless acetabular cup and Klassic HD femoral stem. Postoperative management included early range of motion and gait training. Patients were allowed full protected weight bearing immediately after surgery for six weeks, followed by weight bearing with a crutch or cane until they had no limp. Anticoagulation protocol consisted of Warfarin (5mg) the night before surgery, then continued for 3 weeks aiming for an INR of 2. Patients took 81 mg of ASA until three months post operatively.

Sizing of the implant was based on preoperative templating as well as intraoperative surgeon discretion. Postoperative follow up was performed at three and six weeks; three, six and nine months; and then annually thereafter. Complications and additional surgeries were documented. Clinical and radiographic evaluation was performed at each follow up, and HHS were recorded at final follow up appointment. All radiographs were assessed by the senior author (AAH) and an orthopedic fellow, examining for heterotopic bone according to the Brooker classification [7], osteolytic lesions, stability, subsidence, and pedestal formation. Osteolytic lesions were classified around the acetabulum according to DeLee and Charnley [8] and around the femur according to Gruen, et al. [9] Subsidence was measured as defined by Loudon [10].

Results

At final follow up, six patients were deceased for reasons unrelated to their total hip arthroplasty and nine were lost to follow up. Average age of the patients was 71 years old (range 48 to 99 years) with 44% male participants, and an average patient weight of 197 lbs. The decision to use a cementless stem was based on preoperative review of the radiographic anatomy of the proximal femur. Patients with Dorr Type A, B and C proximal femora [11] were considered candidates for cementless components. The patient's health and activity level were also considered with a final decision made intraoperatively based on the stability of the final broach. No cemented components were used during this interval.

HHS were collected at final follow up with an average of 89 (range of 71 - 100). Four hematomas occurred (prior to the senior author's regular use of tranexamic acid) and were successfully treated with a superficial incision and drainage, including one of the hematomas that was thought to be infected. One patient had a closed reduction for dislocation and one patient had a constrained liner placed for recurrent dislocation. Five-year survivorship of the stem in this cohort was 100%. The survivorship of the cup was 99%. No revisions were due to pain or osteolysis and there was zero incidence of thigh pain or aseptic loosening. Radiographic evaluation demonstrated no incidence of subsidence or instability (Figure 2). One patient, who required a constrained liner due to recurrent dislocations, and had a Brooker class 2 heterotopic bone formation.

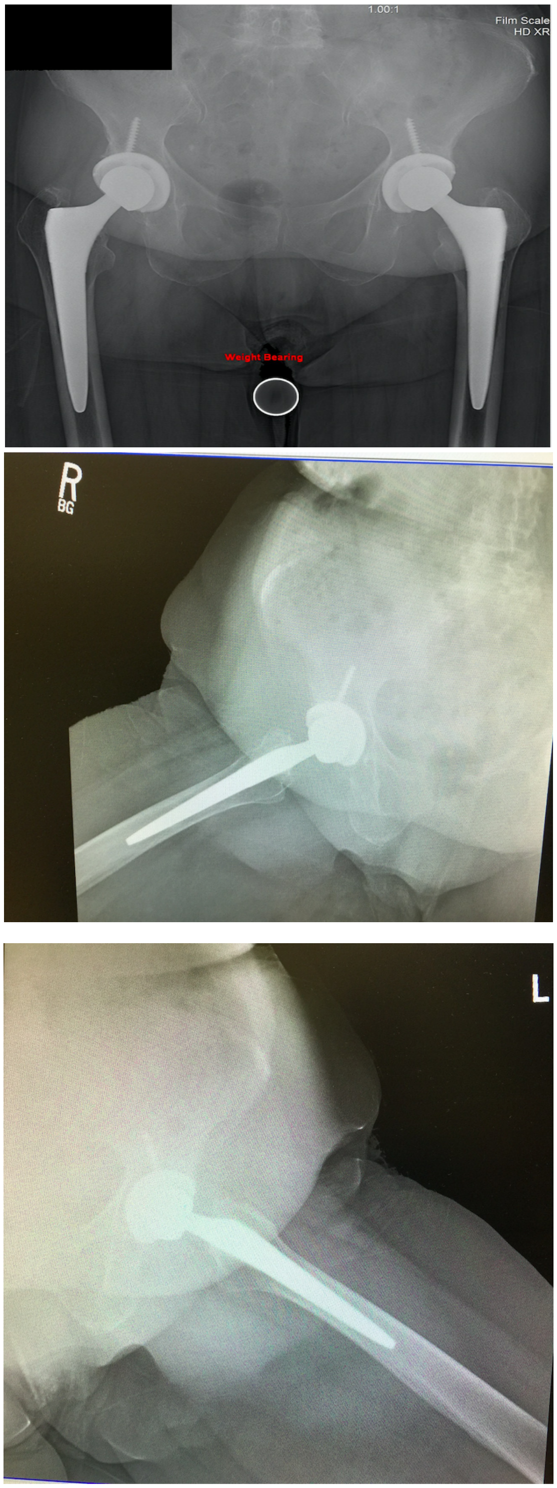

Figure 2: 83-year-old patient with bilateral THA performed in 2013 using TJO Klassic Implants. Courtesy of Hofmann Arthritis Institute.

One incidence of psoas tendonitis required revision of the acetabular cup (Figures 3&4). This acetabular cup was explanted from 54-year-old female following 28 months in situ and was fixed in 10% neutral buffered formalin (10% NBF), dehydrated in ascending grades of ethanol, infiltrated, and then embedded in Polymethyl Methacrylate (PMMA). Once the specimen was polymerized, 2-3 mm thick slices were sectioned from the polymerized blocks using a custom, water cooled, high-speed saw. The sections were ground and polished to an optical finish using a variable- speed grinding wheel and imaged using Scanning Electron Microscopy (SEM) followed by staining and light microscopy. The specimens demonstrated up to 54% bone present within the available pore space of the porous coating (Figures 5, 6&7).

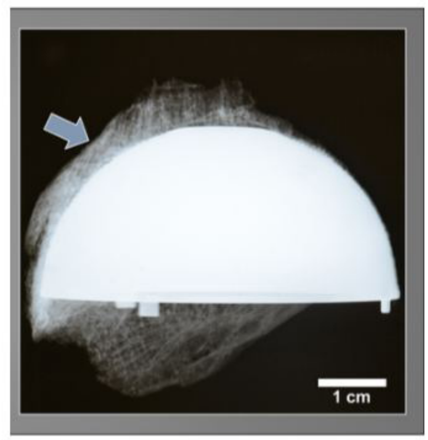

Figure 3: Radiography of the acetabular cup. Implant=White, Bone=Grey. Note the large amount of bone (blue arrows) on the surface of the acetabular cup**.**

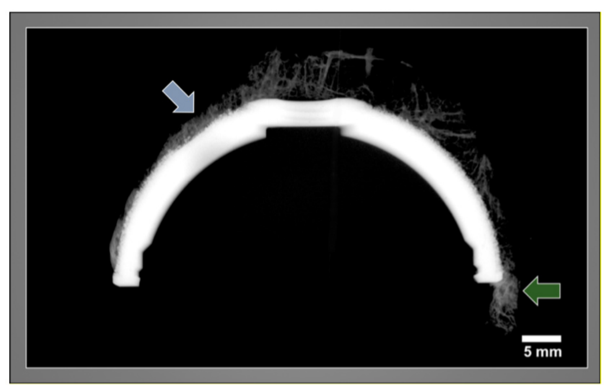

Figure 4: Microradiographs of a 2-3 mm PMMA section from the Klassic HD® acetabular cup. Implant=White, Bone=Grey. The microradiographs complimented what was observed in the macro radiography, that a large amount of bone was present in the periprosthetic regions along with good bone apposition (blue arrow) to the porous coating. The microradiographs also demonstrated bone extending below the implant (green arrow).

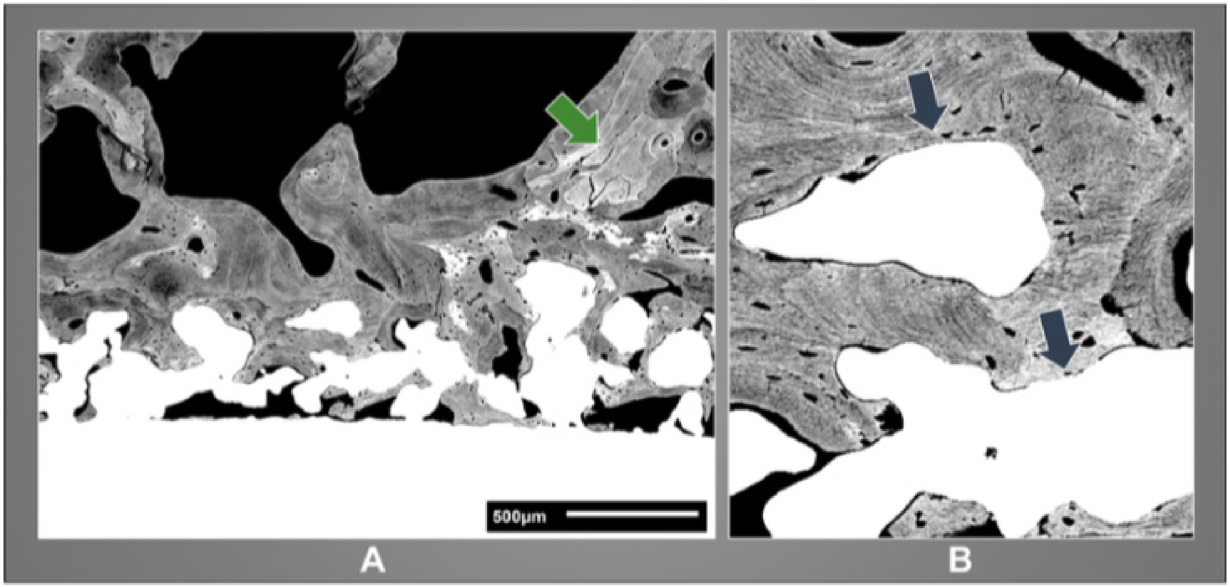

Figure 5: This figure demonstrates bony attachment within the porous coating. White=Implant, Grey=Bone and Black=Pore Space and Soft Tissue. **(A)** BSE (backscatter electron detector) micrograph showing good bone attachment to the porous coating. Note the darker grey color of the bone compared to the lighter grey (green arrow) in the periprosthetic region. This differentiates newer bone growth (dark grey) to host bone (light grey). **(B)** Higher power view of image A showing good osseointegration (blue arrows) to the porous coating along with elongated lacunae and lamellae lines which are signs of mature bone.

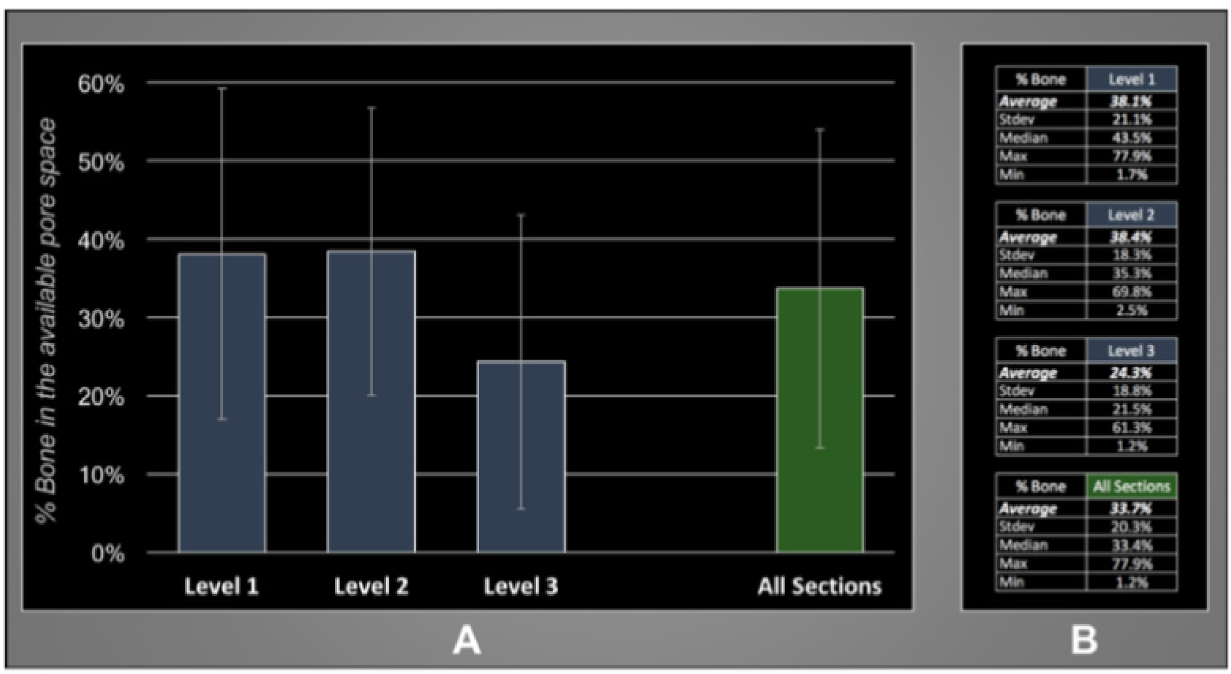

Figure 6: (A) Chart showing the amount of bone present within the available pore space of the porous coating for the three levels that were analyzed (33.7±20.3%). **(B)** Detailed data from the SEM % bone analysis.

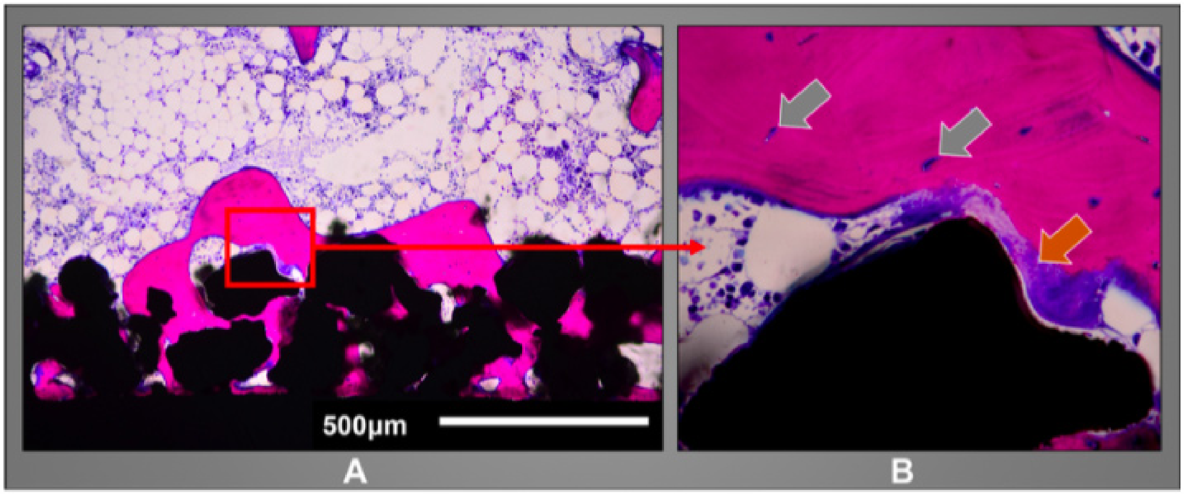

Figure 7: Light microscope micrographs stained with SRBS. Black=Implant, Pink=Bone, Blue=Fibrous Tissue & White=Pore Space. **(A)** Light microscopy micrograph showing good bone attachment to the porous coating. **(B)** Higher power view of image A showing osteocytes (grey arrows) present within the lacunae along with osteoid adjacent to the porous coating (orange arrow). This suggest the bone was healthy, viable, remodeling and still advancing onto the porous coating.

Light Microscope Description: Following SEM imaging, two sections were ground to a thickness of approximately 75 µm and stained with Sanderson's Rapid Bone Stain™ (SRBS). The stained sections were visually examined using a light microscope (Nikon E600, Nikon Inc., Melville, NY) equipped with associated image capturing software (Nikon Control Pro). The findings of the histological evaluation showed that there was no adverse foreign body reaction due to the implant material. The analysis demonstrated viable bone with osteoid present (Figure 3). These findings correlated with what was observed in the SEM analysis.

Discussion

This study demonstrates the safe and effective use of cementless total hip arthroplasty at five year follow up. Implant survivorship and HHS were noted to be excellent, with low rates of revisions and no recorded incidence of thigh pain using this modern generation titanium stem. First generation stems were often cobalt chrome, straight, and fully porous coated and even though survival at minimum 10 years has been reported to be high, thigh pain was present in a significant percentage of patients [3,7,12,13]. Other first-generation stems have been followed for several years with high success. Keisu, et al. [5] and Grant, et al. [14] described their results using a long, fully coated, beaded, cobalt-chrome stem with 94% and 98% survival rates respectively. The authors' only criticism was the difficulty in extracting the stem during revision and a trend toward proximal femoral bone loss.

Blade style tapered stems have also been reported to have excellent survivorship, showing decreasing incidence of thigh pain, however, subsidence was noted more frequently on radiographs by Davies, et al. [15] In comparison, our stem had no incidence of subsidence, and a retrieval study of the acetabular component demonstrated excellent bony ingrowth with up to 54% of bone present in the porous space available. To date, many studies have reviewed the clinical and radiographic outcomes of other Zweymuller-style stems. Ottink, et al. [13] 2015 demonstrated 100% survivorship of the stem at 10 years, and all femoral stems showed radiographic evidence of bony on-growth. More recently, Cruz, et al. [16] howed only two femoral stems loosening at 25 years with total stem survivability of 95.9%.

Although the four hematomas in this cohort were disappointing, this complication has all but disappeared with the current use of Tranexamic Acid (TXA). Hematoma formation is noted to be the third most common complication [12] in total hip arthroplasty, and with the advent of TXA total blood loss has decreased by 30% [17,18]. The author's protocol is 1 gram of TXA prior to skin incision, and 1 gram at the conclusion of surgery. During our five year follow up we experienced two patients who dislocated, giving our cohort a 2% dislocation rate. The incidence of dislocation has been reported as high as 2.4% in the 90 days following an elective total hip [19], and the national average is 3.9% as calculated via medicare claims [20]. In summary, our study demonstrates excellent results with this cementless total hip arthroplasty design, showing outstanding HHS, zero incidence of aseptic loosening, and a low revision rate.

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