



## Original research

# An Orthopedic Surgeon's Dental Examination: Reducing Unnecessary Delays in Joint Replacement Surgery for Marginalized Patients in a Safety Net Hospital System

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## ABSTRACT

**Background:** Selective dental clearance before total joint arthroplasty (TJA) has been proposed; however, effective strategies of carrying out this practice are lacking. This study aims to determine the positive predictive value (PPV) of a novel oral examination performed by an orthopedic surgeon to better direct limited resources for marginalized patients in a safety net hospital system.

**Methods:** A retrospective review was conducted on 105 consecutive patients who had an oral examination performed by a single surgeon before elective TJA. Patients who screened negative proceeded to surgery without further formal dental clearance. Patients who screened positive underwent formal examination/intervention by a dentist before surgery. The rate of correct referral that resulted in patients undergoing an oral surgical intervention was determined. Complications during a minimum 90-day postoperative follow-up period were collected and compared.

**Results:** Thirty patients (28.6%) screened positive while 75 patients (71.4%) screened negative and proceeded to surgery without referral. The PPV of the screening test was high, with 73.3% of patients receiving a major surgical oral intervention before TJA. Patients sent for formal referral required 89.1 more days to receive their surgery than those that screened negative (54.9 days  $\pm$  4.24 vs 144.0 days  $\pm$  82.4,  $P < .001$ ).

**Conclusion:** An orthopedic surgeon's oral examination demonstrates a high PPV to identify high-risk patients in need of an oral surgical intervention before TJA. This provides a unique solution regarding over-referral for preoperative dental clearance and avoids delays for marginalized patients considering elective TJA in a safety net hospital system.

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## Introduction

Patients considering elective total joint arthroplasty (TJA) undergo extensive preoperative evaluation to minimize their risk of complications. The potential for hematogenous spread of oral

pathogens to seed the hip and/or knee before, during, or after surgery has led to the common practice of preoperative dental clearance, especially in high-risk populations [1,2]. Recently however, this practice has been questioned as current evidence linking oral infection and periprosthetic joint infection (PJI) remains inconclusive [3,4]. Despite this, poor dental health is still considered to be a modifiable risk factor critical to the success of TJA [5–7].

In the Proceedings of the International Consensus on Orthopedic Infections, 92% of voters agreed that patients with oral disease should receive appropriate interventions before elective TJA while 76% of surgeons agreed that dental clearance should not be required for all patients undergoing TJA [3]. As such, selective dental clearance appears to be the most reasonable approach to

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limit the burden of unnecessary dental evaluations [8]. This approach may be even more critical to adopt at resource-limited facilities such as safety net hospital systems (SNHS) where marginalized patient populations often lack routine access to dental care [7].

Moreover, patients with lower socioeconomic status have been shown to have a higher prevalence of hip and knee arthritis [7,9]. In addition, these patients experience longer delays to surgery and worse quality of life while waiting for TJA [10]. The costs of dental clearance can be a substantial burden [6], and these costs have been shown to disproportionately impact underserved patient populations [11]. To improve and streamline the care of our patients, the senior author (RR) implemented the present study implemented a simplified dental examination during the preoperative visit for patients undergoing TJA. The purpose of this study was to determine the positive predictive value (PPV) of this novel dental examination in an effort to appropriately direct limited resources at an SNHS and avoid unnecessary surgical delays. The primary outcome was to assess the PPV of the examination in which patients sent for dental referral underwent oral surgical procedures before TJA. The secondary outcome was to compare rates of postoperative complications between patients referred for formal preoperative dental evaluation and those who screened negative by the orthopedic surgery team.

## Material and methods

Institutional review board approval was obtained for this retrospective cohort study at a single academic safety net county hospital. Patients undergoing primary TJA from September 1, 2019, to October 31, 2020, were identified using current procedural terminology codes for primary total knee arthroplasty, total hip arthroplasty, and conversion hip arthroplasty (27477; 27130; and 27132, respectively). All patients included had a minimum 90-day postoperative follow-up to capture immediate complications. Patients with <90-day follow-up or who underwent unicompartmental knee arthroplasty or revision total knee arthroplasty were excluded.

In collaboration with the department of dentistry at our institution, the senior author (RR) received training on performing an oral examination pertinent for preoperative clearance. The training included a PowerPoint presentation (Appendix 1) and observation in the dental clinic for examples of pathology that warranted referral before arthroplasty. The surgeon's clinical assessment was performed at each patient's initial consultation and consisted of a 1- to 2-minute examination of the teeth and gums. The oral mucosa was examined for any signs of infection including gross abscesses, dental caries, residual roots, and gross calculi. The teeth were palpated to assess for tooth or crown mobility. Dental implants were inspected for mobility and any surrounding abscesses. Patients who screened negative proceeded with TJA without formal clearance by a dentist. Patients who screened positive underwent formal dental examination and possible treatment by a dentist before TJA.

Patient demographic data including age, sex, ethnicity, primary language spoken, body mass index, smoking history, American Society of Anesthesiologists (ASA) physical status, Charlson Comorbidity Index, and indication for surgery were collected. A history of diabetes mellitus or inflammatory arthritis was also recorded. Furthermore, a comparative analysis of these perioperative demographics was performed between the screened negative and screened positive cohorts. Moreover, the time from preoperative assessment to index surgery, operative time, the length of hospital stay, and the duration of follow-up after surgery were compared between both cohorts.

The primary outcome was the PPV of the dental screening test (ie, those patients who screened positive by the orthopedic surgeon, who were sent to a dental provider, and who underwent an invasive oral procedure). Secondary outcome measures included 90-day medical and surgical complications that occurred to capture immediate perioperative complications. These complications included those related to their index surgery as per guidelines set in previous studies looking at standardized arthroplasty complications [12,13]. Examples of complications included, but were not limited to, bleeding, wound complications, thromboembolic disease, neural deficit, vascular injury, PJI, intraoperative/postoperative fracture, instability, dislocation, leg-length discrepancy, and stiffness. Furthermore, any complications that occurred after the 90-day follow-up until each patient's most recent visit was documented. Finally, documentation of all patients' previous dental visits was obtained, if available.

## Perioperative management

All patients included in the present study were enrolled into an institutional rapid recovery protocol for TJA. This included preoperative patient education, medical optimization, an emphasis on spinal anesthesia with multimodal pain management techniques to reduce opioid utilization, and avoidance of indwelling urinary catheters and closed suction drainage. Patients were counseled on the importance of early mobilization with physical therapy with the goal of either same-day or next-day discharge. Wound closure was consistent and included a subcuticular running absorbable suture followed by adhesive skin closure. All patients received the same perioperative antibiotics with cefazolin and deep vein thrombosis prophylaxis with aspirin.

## Statistical analysis

All statistical analyses were completed with SPSS Statistics (version 10.15 for macOS; IBM, Chicago, IL) using a two-sided level of significance of 0.05. ASA scores were analyzed as categorical data while Charlson Comorbidity Index scores were analyzed as continuous variables for the purposes of hypothesis testing similar to previous studies [14,15]. All continuous variables were analyzed via unpaired t-tests, and all categorical data were analyzed by Fisher exact tests.

## Results

There were 105 patients that met inclusion criteria. Our screening process yielded 30 patients (28.6%) that screened positive and were referred for formal dental clearance, whereas 75 patients (71.4%) screened negative and underwent TJA without formal dental clearance. Of the 30 patients sent for referral, 22 patients (73.3%) underwent oral surgical treatment, six patients (20.0%) underwent a general cleaning, and two patients (6.7%) did not receive any intervention. Root canal treatment was performed on 12 patients (40.0%). There were 20 of 30 patients (67.7%) of patients that required dental extractions. Overall, the screening test produced a PPV of 73.3% of patients receiving a major surgical oral intervention before TJA, with 93.3% receiving some form of intervention before TJA (Table 1). Preoperative baseline demographics are identified in Table 2 comparing screened negative and screened positive groups. There were no significant differences in age, gender, or body mass index. There were two subjects in the screened negative cohort that underwent conversion total hip arthroplasty; hardware removal was not required in either case. In addition, patients that were sent for formal dental referral had significantly longer delays to surgery and waited 89.1 more days to receive their surgery than those that screened negative ( $144.0 \pm$

**Table 1**  
Results of dental screening and type of intervention received among screened positive patients.

Total # of patients <sup>a</sup>	105
Patients screened negative for dental disease	75 (71.4%)
Patients screened positive for dental disease	30 (28.6%)
Patients sent for formal dental evaluation <sup>a</sup>	
Patients received surgical intervention	22 (73.3%)
Patients received general cleaning	6 (20.0%)
Patients received no intervention	2 (6.7%)

<sup>a</sup> The values are given as the number of patients, with the percentage in parentheses.

82.4 days vs 54.9 ± 4.24 days;  $P < .001$ ). There was no significant difference in the duration of follow-up between both cohorts (216.2 ± 104.3 days vs 193.8 ± 92.7 days,  $P = .281$ ) or length of hospital stay (1.04 ± 0.41 days vs 1.01 ± 0.42 days,  $P = .794$ ).

Among the screened negative cohort ( $n = 75$ ), 46 (61.3%) patients had a prior documented dental visit. Fourteen patients

(30.4%) had seen a dentist within 3 months before their orthopedic consultation, 24 patients (52.2%) had seen a dentist between 3 months and 1 year, and 8 patients (17.4%) had not seen a dentist in over 1 year. Within the screened positive cohort ( $n = 30$ ), 27 patients (90%) had a prior documented dental visit. Four patients (14.8%) had seen a dental care provider between 3 months and 1 year, and 23 patients (85.2%) had not seen a dental care provider in over 1 year (Fig. 1). There were significantly more patients in the screened positive cohort that had not seen a dental provider in more than 1 year (23 [85.2%] vs 8 [10.7%],  $P < .001$ ).

Table 3 displays the difference in complication rates between groups. There were significantly more 90-day postoperative complications in the screened positive group than those in the screened negative group (8 [26.7%] vs 8 [10.7%],  $P = .039$ ). While there were no acute medical complications in the screened positive group, there were two acute medical complications in the screened negative group, which included one patient developing postoperative hypotension that resolved without further treatment and one patient that developed a provoked pulmonary embolism.

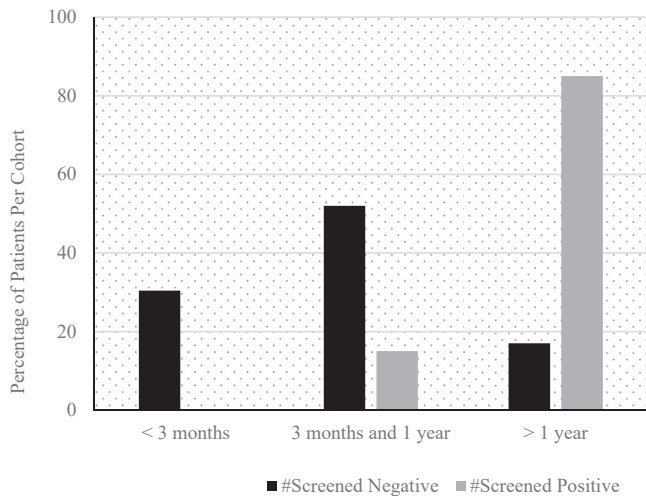
**Table 2**  
Cohort demographics and perioperative variables.

Total number of patients: 105	Screened negative ( $n = 75$ )	Screened positive ( $n = 30$ )	<i>P</i> value
Age <sup>b</sup>	60.7 ± 11.8 [58.0, 63.4]	60.6 ± 8.8 [57.3, 63.9]	.961
Sex			
Male	20	11	.893
Female	55	19	.224
Height <sup>b</sup>	159.8 ± 10.3 [157.4, 162.2]	160.8 ± 11.8 [156.4, 165.2]	.682
Weight <sup>b</sup>	78.4 ± 12.7 [75.5, 81.3]	81.1 ± 19.4 [73.8, 88.3]	.483
Body mass index (kg/m <sup>2</sup> ) <sup>b</sup>	30.7 ± 4.0 [29.8, 31.6]	31.0 ± 5.3 [29.1, 33.0]	.721
Ethnicity <sup>a</sup>			
Hispanic	53	22	
African American	13	4	
Caucasian	3	3	
Asian	3	1	
Other	3	0	
Primary language <sup>a</sup>			
English	21 (28.0%)	6 (20.0%)	.381
Non-English	54 (72.0%)	24 (80.0%)	.391
THA <sup>a</sup>	16 (21.3%)	9 (30.0%)	.443
Conversion THA	2 (2.67%)	0	.90
TKA <sup>a</sup>	59 (78.7%)	21 (70.0%)	.345
Surgical diagnosis			
Osteoarthritis	59 (78.6%)	21 (70.0%)	
Rheumatoid arthritis	9 (12.0%)	6 (20.0%)	
Avascular necrosis	2 (2.7%)	2 (6.7%)	
Hip dysplasia	4 (5.3%)	0	
Posttraumatic OA	6 (8.0%)	1 (3.3%)	
Ankylosing spondylitis	1 (1.3%)	0	
Blount disease	1 (1.3%)	0	
Medical comorbidities <sup>a</sup>			
Diabetes mellitus	20 (26.7%)	7 (23.3%)	.727
Preoperative HbA1c	6.5%	6.7%	.281
Inflammatory arthritis	9 (12.0%)	6 (20.0%)	.294
No. of patients seen by dentist > 1 yr	8 (10.7%)	23 (76.7%)	<b>&lt;.001</b>
ASA score <sup>a</sup>			
≤ 2	43 (57.3%)	12 (40.0%)	.085
3	32 (42.7%)	18 (60.0%)	.085
Age-adjusted Charlson Comorbidity Index <sup>b</sup>	2.5 ± 1.6 [2.2, 2.9]	2.4 ± 1.3 [2.0, 2.9]	.321
Time from preoperative assessment to surgery (d)	55.0 ± 36.8 [46.5, 63.4]	144.0 ± 82.4 [113.3, 174.9]	<b>&lt;.001</b>
Duration of follow-up <sup>b</sup> (d)	216.2 ± 104.1 [192.2, 240.1]	193.8 ± 92.7 [159.1, 228.4]	.281
Operative time (min)	153.6 ± 35.3 [145.5, 161.8]	163.5 ± 36.7 [149.8, 177.2]	.214
Length of hospital stay (d)	1.0 ± 0.4 [0.86, 1.2]	1.0 ± 0.4 [0.9, 1.1]	.794
Tobacco use <sup>a</sup>			
Never smokers	60 (80.0%)	24 (80.0%)	1.000
Former smokers	15 (20.0%)	6 (20.0%)	1.000
Current smokers	0	0	

HbA1c, hemoglobin A1c; THA, total hip arthroplasty; TKA, total knee arthroplasty; OA, osteoarthritis. 95% Confidence intervals are displayed in brackets. Bolded *P* values indicated statistical significance.

<sup>a</sup> The values are given as the number of patients, with the percentage in parentheses.

<sup>b</sup> The values are given as the mean and the standard deviation, with the range in parentheses.



**Figure 1.** Histogram graph depicting percentage of patients in each cohort and when they were last seen by a dental provider. Within 3 months; between 3 months and 1 year; and over 1 year before the initial orthopedic consultation. No patients in the screened positive cohort had seen a dentist within 3 months of their orthopedic consultation.

There were significantly more patients in the screened positive group that developed a superficial wound complication (7 [23.3%] vs 5 [6.7%],  $P = .015$ ). With the exception of one patient in the screened negative cohort, all patients in both cohorts with superficial wound complications were treated successfully with local wound care, with two of the patients from the screened negative cohort also requiring the use of oral antibiotics. Of note, 8 of these 12 patients (75%) had a diagnosis of cirrhosis or inflammatory arthritis, which may have contributed to delayed wound healing. Inflammatory laboratory markers were drawn and trended for all patients, which appropriately decreased after nonsurgical interventions. All patients were seen at their most recent follow-up visit with fully healed incisions and no residual wound complications. There was one patient with rheumatoid arthritis in the screened negative cohort who experienced a superficial wound dehiscence on postoperative day 33 that required formal debridement in the operating room after failing a short course of wound vacuum therapy in clinic and oral antibiotics. Before antibiotics were given, aspiration was performed, and both cultures and synovial fluid analysis were negative for infection (nucleated cell count: 250 cells/ $\mu\text{L}$ , 56% of polymorphonuclear leukocytes, and no growth on cell cultures taken). Synovasure (Zimmer Biomet, Warsaw, IN) and synovial C-reactive protein tests are not available at

our institution. Despite these findings, the patient continued to have a persistent distal wound. A repeat aspiration yielded a nucleated cell count of 21 cells/ $\mu\text{L}$ , 48% polymorphonuclear leukocytes, and no growth on cell cultures. The patient was subsequently taken to the operating room for superficial debridement without violation of the arthrotomy or exchange of modular components. The patient was placed on oral antibiotics for 7 days and has since remained infection-free, now 14 months from debridement. One patient in the screened positive group developed an acute PJI with preoperative aspiration and intraoperative cultures both positive for methicillin-sensitive *Staphylococcus aureus*. Although the bacterial organism is typical of oral flora [16], the likelihood of an acute hematogenous seeding is low given that his dental procedure was performed approximately 7 months before his index surgery. The patient underwent irrigation and debridement with polyethylene component exchange and has remained infection-free for 12 months. Moreover, there was only one complication found after 90 days of follow-up as one patient in the screened negative group developed iliotibial band tendonitis, which was treated conservatively.

## Discussion

In the evaluation of a novel, surgeon-directed dental examination, our screening test demonstrated a high PPV in identifying patients that required an invasive oral procedure before TJA. The PPV of the screening test was 73.3% of patients receiving a major surgical oral intervention before TJA with 93.3% receiving some level of intervention. Most patients (71.4%) in the study went on with their TJA without formal evaluation by a dentist. Notably, these patients did not demonstrate increased complications in the short term compared with the screened positive cohort. Those that required a formal dental evaluation or treatment experienced, on-average, nearly 3 months (89.1 days) in delay of their arthroplasty procedure.

While previous studies have casted doubt on the utility of preoperative dental clearance and its effect on outcomes after TJA [6,8], poor dental health is still recognized as a modifiable risk factor that can theoretically increase the risk of PJI [17]. As such, a selective approach is reasonable to identify high-risk patients that would most benefit from formal dental evaluation and treatment before arthroplasty. By only referring high-risk individuals, the remaining patients avoid surgical delays, which was substantial in the current study where patients that required dental evaluation waited almost 3 months longer for surgery. Selective dental clearance thus provides even greater benefits to marginalized patients who historically experience longer delays to TJA and worse quality of life while waiting [13].

**Table 3**  
Medical and surgical complications among the screened negative and positive patients.

Type of complication <sup>a</sup>	Screened negative (n = 75)	Screened positive (n = 30)	P value
Total complications	9 (12.0%)	8 (26.7%)	.065
90-d Complications	8 (10.7%)	8 (26.7%)	<b>.041</b>
Acute medical complication	2 (2.7%)	0	.371
Pulmonary embolism	1	-	
Postoperative hypotension	1	-	
Superficial surgical wound complication	5 (6.7%)	7 (23.3%)	<b>.015</b>
Acute PJI	0	1 (3.3%)	.502
Complications after 90-d period	1 (1.3%)	0	.525
ITB Tendonitis	1	-	
Return to OR needed	1 (1.3%)	1 (3.3%)	.114

ITB, iliotibial band; OR, operating room.

Bolded P values indicated statistical significance.

<sup>a</sup> The values are given as the number of patients, with the percentage in parentheses.

Owing to the morbidity and economic burden associated with PJI, identifying any modifiable risk factors to limit its occurrence is valuable. It has been estimated that 6%–13% of all cases of PJI are due to oral bacteria [18]. Moreover, several studies have shown late hematogenous joint infections occurring after dental treatment [19–21]. While these findings pertain to issues of dental treatment after surgery, they have clear implications regarding dental clearance before TJA. Although the number of patients included in the present study is small and underpowered to detect differences in PJI, we found no significant differences with regard to acute PJI between screened negative and screened positive patients (0.0% vs 3.3%  $P = .114$ ). A larger sample size would be required to further validate this claim and reduce the risk of committing a type II error.

A recent review by Sonn et al. showed that patients who required tooth extractions before TJA were at higher risk of complication than those that did not [22]. Our study showed similar findings in that patients who were sent for clearance after dental screening had a higher complication rate. While not statistically significant in the present study, those failing the screening examination tended to have higher ASA scores, possibly indicating an overall poorer health status. Thus, similar to conclusions drawn in previous studies, the higher complication rate seen in the screened positive group of the present study was possibly due to the correlation of poor dental health with poor overall health maintenance and management of chronic comorbidities [23,24].

While previous studies have been conducted to identify high-risk patients requiring dental clearance [2,4], our study is the first to implement a simplified dental examination performed by an orthopedic surgeon to screen for patients who require a dental procedure before TJA. This novel screening and evaluation tool was developed and applied at an SNHS, where patients are likely to have the highest risk for dental issues without consistent access to dental care [25]. The screening examination is reasonably effective in identifying high-risk patients as the results of the present study demonstrated a PPV for major oral intervention of 73.3%. Working in an underserved community has highlighted that the success of this screening process requires collaboration among all care providers engaged in the preoperative assessment of patients undergoing elective TJA: surgeons, primary care providers, dental providers, and anesthesiologists. By taking a multidisciplinary approach through effective education and discussion among providers, solutions to improve care and direct limited resources appropriately are achievable.

There are limitations to the study including those inherent to retrospective studies performed at a single institution with a limited sample size. While our study was designed to assess the PPV of a screening test to identify high-risk patients requiring oral intervention, the results comparing the cohorts studied may be confounded by other factors not assessed including documenting specific oral habits (ie, flossing, brushing frequency, and so on) or their correlation with other routine health examinations or compliance with medication recommendations. Furthermore, we were unable to have all patients examined by a dentist because of the limited resources in the county hospital system. As such, we could not determine the true accuracy of our screening method. In addition, while our results demonstrated that high-risk patients tended to have more complications, the number of patients included in the present study was relatively small and underpowered to accurately detect significant differences in major complications such as PJI. Our post-hoc analysis to detect a 0.5% difference in PJI between both groups would require a sample size of 10,000 subjects to be 80% powered. As such, our study is limited in the conclusions that can be made regarding the comparison of secondary outcome measures of complications between both cohorts. In addition, as only the senior author performed all dental screening examinations,

a measurement bias may be present, likely limiting the external validity of the study. Moreover, our study only measured outcomes in the short term. Previous studies have shown late hematogenous joint infections occurring after the dental treatment [18,19]. Further studies are necessary to compare the long-term complication rates between the cohorts examined in the present study.

Finally, the purpose of the proposed oral examination is to avoid unnecessary referral to dental providers for preoperative clearance, as those patients who required dental evaluation preoperatively had nearly 3 months in delay to arthroplasty. Our intention is not to replace the service of dental providers for underserved patients but to avoid unnecessary barriers to arthroplasty. The issue of creating strategies to allow for universal dental care for all patients is beyond the scope of our study. However, recognizing the socioeconomic, racial, and language barriers inherent of an underserved population is critical to promote health literacy and to improve the outcomes for all patients.

## Conclusions

The study highlights the use of a novel routine oral examination performed by an orthopedic surgeon to selectively identify high-risk patients that would require an oral surgical intervention before an elective TJA. In the present series, the screening test demonstrated a PPV of 73.3% of patients sent for referral who received an invasive dental procedure before arthroplasty. Formal preoperative dental evaluation and interventions resulted in, on average, a delay of 89.1 days to arthroplasty. Although the study was underpowered to detect differences in PJI, those patients who cleared the dental screening examination did not show increased rates of complication in the short term. The present study, therefore, may provide a unique solution to the issue of over-referral for preoperative dental clearance and helps to avoid delays in care for patients considering elective TJA, especially in an SNHS with limited resources and access to care.

## Conflicts of interest

The authors declare there are no conflicts of interest.

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