Arthroplasty Today 33 (2025) 101679

Contents lists available at ScienceDirect

Arthroplasty Today

journal homepage: http://www.arthroplastytoday.org/

Original Research

Body Mass Index as a Risk Factor for Readmission Rates in Direct Anterior Approach Total Hip Arthroplasty

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ARTICLE INFO

Article history:
Received 19 November 2024
Received in revised form
14 February 2025
Accepted 9 March 2025
Available online xxx

Keywords:
Primary total hip arthroplasty
Perioperative complications
BMI

ABSTRACT

Background: Multiple studies have examined the relationship between obesity and increased risk of perioperative complications in patients undergoing total hip arthroplasty (THA). The purpose of this study was to compare the rate of perioperative complications stratified by body mass index (BMI) in patients undergoing THA through a direct anterior (DA) approach.
Methods: A retrospective review at a single high-volume orthopaedic specialty hospital identified all DA THAs performed between January 2019 and August 2022. Patients were stratified by BMI into the following cohorts: underweight (BMI<18.5), normal (BMI = 18.5-25), overweight (BMI = 25-30), obese class I (BMI = 30-35), obese class II (BMI = 35-39.9), and obese class III (BMI ≥ 40). Primary outcomes collected included 30-day and 90-day readmissions, emergency department visits, intraoperative fracture, and 90-day infection requiring return to the operating room. There were 4767 patients with a mean BMI of 28 kg/m^2 (15.5-54.5) and a mean age of 67 years (18-100 years).
Results: Thirty-day readmission rates in the obese class III (6.2%) were significantly higher when compared individually to all other cohorts (P < .001). Additionally, logistic regression found that underweight patients had an increased likelihood of an intraoperative fracture (odds ratio [OR]: 13.120, 95% confidence interval [CI]: 1.172-146.930, P < .001), and both obese classes I and III were more likely to have a 90-day infection that required a return to the operating room (OR: 8.508, 95% CI: 1.023-70.779, P < .001 and OR: 29.853, 95% CI: 2.683-332.187, P < .001, respectively).
Conclusions: Obese class III patients have a higher rate of 30-day readmission following DA THA than all other BMI cohorts and are at increased risk of infection requiring return to the operating room when compared to patients with normal BMI. Surgeons should counsel patients regarding the increased potential complication risks related to BMI.

Introduction

With estimations of over 600,000 cases to be performed annually in the next decade, total hip arthroplasty (THA) will remain one of the most common surgical procedures performed in the United States. [1] Over the same time period, obesity rates have steadily risen in the United States and are expected to continue to rise in the coming years. [2,3] Greater than 35% of the U.S. population suffers from obesity, making large body habitus a challenge surgeons manage on a daily basis. [2] Research has indicated health problems like diabetes, cardiovascular disease, pulmonary disease, metabolic syndrome, and obstructive sleep apnea are all aggravated by obesity, and obesity itself is linked to the development of osteoarthritis. [4,5] Furthermore, obesity is associated with advanced onset of debilitating joint destruction requiring THA at younger ages and is a known risk factor for complications following THA. [6-12]

Initially pioneered over 40 years ago, the direct anterior (DA) approach has been a longstanding, albeit previously rarely used option for THA. [13,14] Popularity has been steadily increasing over the last 2 decades after refinement of the procedure by Matta et al.

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https://doi.org/10.1016/j.artd.2025.101679

in 2005. [15,16] DA is associated with a low dislocation rate, and previous research has suggested both a shorter length of stay (LOS) and better short-term outcomes when compared to other THA approaches. [17-23] These advantages are attractive as more THA procedures are migrating into the outpatient setting. [24-26]

Obesity's association with increased complications has translated to significantly increased cost in bundled patients· [27] Consequently, increasing attention has been dedicated to the minimization of complications in THA. [28] Registry data have shown DA to be associated with a small but significant risk of major complications within 1 year of THA, and certain patient populations have been found to be more prone to wound complications with the DA than the posterior approach. [23,29,30] In general, increased complications have been noted in DA patients with obesity. [31-33] However, prior research has used different classifications of obesity, with the largest to stratify by multiple body mass index (BMI) cohorts including less than 2000 patients. [32] The current study reports on a group of 4767 DA THA patients performed at a single, high-volume orthopaedic specialty hospital and separated into six BMI cohorts. To the authors' knowledge, this is the largest study to examine risks associated with DA THA stratified by BMI. We hypothesize that complications will increase with increasing BMI. Additionally, we hypothesize that there will be increased complications in those patients who are stratified into the "underweight" group.

Material and methods

Patient selection

Following institutional review board approval, a retrospective review utilizing an institutional total joint registry at a single high-volume orthopaedic hospital identified unilateral, primary, and nonconversion THAs between January 2019 and August 2022 performed through a DA approach. The review collected patients from 14 surgeons fellowship-trained in total hip arthroplasty with extensive experience in the DA approach. All patients who underwent the procedure within the provided time range were included and stratified by BMI into the following categories: underweight (BMI < 18.5), normal (BMI = 18.5-24.9), overweight (BMI = 25-29.9), obese class I (BMI = 30.0-34.9), obese class II (BMI = 35-39.9), and obese class III (BMI ≥ 40).

Patient characteristics

There were 4767 patients identified who underwent a DA THA between 2019 and August 2022, with a mean age of 67 years (range, 18-100 years), 47% men (n = 2242), a mean BMI of 28 kg/m2 (range, 16-55 kg/m2), and a mean LOS of 0.8 days (range, 0-14). There were 55 patients classified as underweight (BMI > 18.5, 1.15%), 1420 normal (BMI = 18.5-24.9, 29.8%), 1858 overweight (BMI = 25-29.9, 39%), 1006 obese class I (BMI = 30-34.9, 21.1%), 331 obese class II (BMI = 35-39.9, 6.94%), and 97 obese class III (BMI > 40, 2.03%). The American Society of Anesthesiologists (ASA) status was 5% (n = 247) class 1, 3283 class II (68.87%), 1230 class III (25.8%), and 7 class IV (0.15%). Heart disease was present in 2873 patients (60.27%), 470 patients had diabetes (9.86%), and 1330 patients indicated a positive smoking status (27.9%). BMI cohorts were found to be significantly different for gender ($P < .001$), age ($P < .001$), ASA ($P < .001$), and LOS ($P < .001$); however, they were not significantly different for heart disease ($P = .51$), diabetes ($P = .98$), or smoking status ($P = .74$, Table 1).

Table 1
Patient characteristics.

Characteristic	Underweight (BMI < 18.6)	Normal (BMI = 18.6-24.9)	Overweight (BMI = 25-29.9)	Obese class I (BMI = 30-34.9)	Obese class II (BMI = 35-39.9)	Obese class III (BMI > 40)	Total	*P* value
N	55	1420	1858	1006	331	97	4767	
Mean age (y) (mean [range])	71.73 (49-100)	68.59 (18-94)	67.22 (18-93)	66.25 (26-96)	63.84 (25-85)	61.72 (18-86)	67.12 (18-100)	**<.001**
Females, n (%)	54 (98.2)	1039 (73.2)	796 (42.8)	421 (41.8)	165 (49.8)	50 (51.5)	2525 (53)	**<.001**
Mean BMI (kg/m^2) (Mean [range])	17.75 (15.5-18.5)	22.54 (18.6-24.9)	27.31 (25-29.9)	31.99 (30-34.9)	36.96 (35-39.9)	42.62 (40-54.5)	27.75 (15.5-54.5)	
Length of stay (mean [range]), d	0.94 (0-3)	0.82 (0-11)	0.75 (0-14)	0.83 (0-8)	0.88 (0-3)	1.11 (0-4)	0.80 (0-14)	**<.001**
ASA, n (%)								**<.001**
1	4 (7.3)	116 (8.2)	102 (5.5)	25 (2.5)	0	0	247 (5.2)	
2	42 (76.3)	1024 (72.1)	1332 (71.7)	688 (68.4)	171 (51.7)	26 (26.8)	3283 (68.9)	
3	9 (16.4)	277 (19.5)	422 (22.7)	291 (28.9)	160 (48.3)	71 (73.2)	1230 (25.8)	
4	0	3 (0.3)	2 (0.11)	2 (0.2)	0	0	7 (0.15)	
Heart disease, n (%)	37 (67.3)	861 (60.6)	1125 (60.5)	602 (59.8)	200 (60.4)	48 (49.5)	2873 (60.3)	.51
Diabetes, n (%)	4 (7.3)	128 (9)	197 (10.6)	97 (9.6)	36 (10.9)	8 (8.2)	470 (9.9)	.98
Smoking, n (%)	13 (23.6)	394 (27.7)	505 (27.2)	299 (29.7)	91 (27.5)	28 (28.9)	1330 (27.9)	.74

Bolded values denote statistical significance of $P \leq .05$.

Surgical procedure

Patients were treated according to standardized preoperative, perioperative, and postoperative institutional protocols. Prior to admission for surgery, patients were tested for methicillin-resistant Staphylococcus aureus, underwent superficial decolonization at the surgical site, and applied alcohol-based nasal swabs for the 5 days. Preoperatively, patients had site preparation with chlorhexidine cloths and took the following medications: Bicitra 30 ml, Tylenol 650 or 1000 mg, Pepcid 20 mg, and Robaxin 750-1000 mg based on weight and antibiotics prior to incision (cefazolin unless any previously documented anaphylaxis with cefazolin, then vancomycin was used). All patients received 1000 mg of intravenous TXA in accordance with institutional protocols for total joint arthroplasty. During the procedure, betadine solutions were used for irrigation: 500 mL of 0.9% NaCL + 45 mL of povidone iodine (United States Pharmacopeia 10%). If a patient was found to have an allergy to the betadine solution, surgeons then used a 0.05% of chlorhexidine gluconate or 0.9% of NaCl solution for irrigation.

All DA cases were performed in the supine position using the HANA table (Mizuho OSI, Union City, California), providing traction for full joint distraction and enabling abduction, adduction, hyperextension, and flexion of the lower extremity. Following a capsulotomy, the femur was retracted, and a femoral neck osteotomy along the intertrochanteric line was completed for the preparation of the trial components and final implantation. The acetabulum was then reamed for the press fit or, in the event of osteoporosis or acetabular defects, screw-fixated acetabular cup. Prior to impaction of the polyethylene liner, the seating was confirmed through flush alignment with the acetabular cup. Using a box osteotome to create a pilot hole within the femoral canal, broaches were progressively impacted until consistent with the template. The final size broach trial was left within the femoral canal and supplemented with a femoral neck and femoral head component. With all trials in place, the hip was reduced back into position, and articulation was assessed for stability. With confirmed stability, the hip was dislocated, and all trials were removed to make room for the final implant. After leveling with a calcar reamer, the broach and femoral neck were impacted down back into the femoral canal with the femoral head seated flush. The hip was then reduced, and fluoroscopic imaging confirmed satisfactory placement.

Postoperatively, patients received methicillin-resistant Staphylococcus aureus testing if they had an overnight stay at the hospital, and all patients received a final dose of antibiotics (cefazolin unless any previously documented anaphylaxis with cefazolin; then vancomycin was used).

Data collection and statistical analysis

Patient demographic data and comorbidities including ASA class, heart disease, diabetes, and active smoking status prior to surgery were collected. The primary outcomes collected included 30-day and 90-day readmission rates, emergency department (ED) visits within 72 hours, 7 days, and 30 days, intraoperative fractures, and any 90-day infections that required a return to the operating room (RTOR). Following data collection, Pearson's chi-square tests and analysis of variance were conducted to examine association between all primary outcomes with respect to BMI cohorts and gender. A post hoc Bonferroni test was then conducted to find differences in collected outcomes between individual BMI cohorts. All significantly different cohort characteristics were included and controlled as covariates through regression analysis. Binomial logistic regression was used to analyze age, sex, ASA level, LOS, and BMI cohorts for all primary outcomes. For logistic regression, male gender and the normal BMI cohort were used for reference when applicable. Logistic regression results were reported as odds ratios (ORs) with 95% confidence intervals (CIs). Statistical significance was defined as $P \leq .05$.

Results

Initial analysis found significant differences in 30-day readmission rates ($P < .001$) and 90-day infection requiring RTOR ($P = .03$) between BMI classes. Differences in 90-day readmission rates, ED visits within 30 days, inpatient visits within 72 hours, ED visits within 7 days, ED visits within 72 hours, and intraoperative fracture were nonsignificant ($P > .05$, Table 2).

Post hoc tests found 30-day readmission rates in the obese class III cohort (6.2%) to be significantly higher than the underweight (1.8%, $P = .046$), normal (0.5%, $P < .001$), overweight (0.8%, $P < .001$), obese class I (0.9%, $P < .001$), and obese class II (0.0%, $P < .001$) BMI cohorts (Table 3).

As age increased, there was a significantly increased likelihood of an ED visit within 30 days (OR: 1.046, 95% CI: 1.022-1.071, $P < .001$) and an ED visit within 72 hours postoperatively (OR: 1.041, 95% CI: 1.009-1.073, $P = .011$). As ASA category increased, patients were found to be significantly more likely to have a 90-day infection requiring an RTOR (OR: 2.907, 95% CI: 1.176-7.185, $P = .021$). A longer LOS was significantly associated with an increased likelihood of a 30-day readmission (OR: 1.732, 95% CI: 1.399-2.144, $P < .001$), ED visit within 30 days (OR: 1.684, 95% CI: 1.413-2.006, $P < .001$), ED visit within 72 hours (OR: 1.436, 95% CI: 1.182-1.744, $P < .001$), and intraoperative fracture (OR: 1.540, 95% CI: 1.10-2.149, $P = .011$, Table 4).

Underweight patients were found to have a significantly increased likelihood of an intraoperative fracture (1.8%, OR: 13.120, 95% CI: 1.172-146.930, $P < .001$), and obese class I cohort were significantly more likely to have a 90-day infection requiring RTOR (0.6%, OR: 8.508, 95% CI: 1.023-70.779, $P < .001$). The obese class III cohort was found to have a significantly increased likelihood of 30-day readmission (6.2%, OR: 13.3, 95% CI: 4.379-40.390, $P < .001$) and 90-day infection requiring RTOR (2.1%, OR: 29.853, 95% CI: 2.683-332.187, $P < .001$) when compared to the normal BMI cohort. (Table 4)

Discussion

As the prevalence of obesity rises, surgical risks in relation to BMI face increasing importance. [2,3] This is especially relevant within the patient population undergoing total hip arthroplasty, as severe hip osteoarthritis can be debilitating, significantly limiting activity levels. [6-12] This study represents, to the authors' knowledge, the largest high-volume single-center retrospective review of outcomes following the DA approach in total hip arthroplasty stratified by BMI. While not controlled between cohorts, preoperative risk factors such as heart disease, diabetes, and smoking status were found to be strongly nonsignificant between the BMI classes. We hypothesized that complications would increase with BMI and for patients stratified into the underweight group. Our chi-square and analysis of variance analysis supported our hypothesis by finding significant differences in 30-day readmission rates and 90-day infection requiring RTOR between BMI cohorts. Our post hoc Bonferroni test further supported this hypothesis as class III obese patients had a higher 30-day readmission when compared to all 5 other BMI categories individually, indicating a watershed point as BMI exceeds 40. We conducted a logistic regression that supported our hypothesis by finding underweight patients and obese classes I and III had an increased likelihood of intraoperative fracture, return to the OR for infections,

Table 2
Outcome incidence and results of chi-square and analysis of variance analyses.

Outcome	Total, n (%)	Underweight (BMI <18.6), n (%)	Normal (BMI = 18.6-24.9), n (%)	Overweight (BMI = 25-29.9), n (%)	Obese class I (BMI = 30-34.9), n (%)	Obese class II (BMI = 35-39.9), n (%)	Obese class III (BMI >40), n (%)	*P* value
Thirty-day readmission	37 (0.8)	1 (1.8)	7 (0.5)	14 (0.8)	9 (0.9)	0 (0)	6 (6.2)	**<.001**
Ninety-day readmission	6 (0.1)	0 (0)	0 (0)	3 (0.2)	3 (0.3)	0 (0)	0 (0)	.42
ED visits within 30 d	89 (1.9)	0 (0)	34 (2.4)	28 (1.5)	22 (2.2)	4 (1.2)	1 (1.0)	.284
ED visits within 72 h	49 (1)	0 (0)	19 (1.3)	15 (0.8)	12 (1.2)	3 (0.9)	0 (0)	.531
ED visits within 7 d	35 (0.7)	1 (1.8)	15 (1.1)	9 (0.5)	8 (0.8)	2 (0.6)	0 (0)	.375
Intraoperative fracture	10 (0.2)	1 (1.8)	2 (0.1)	6 (0.3)	1 (0.1)	0 (0)	0 (0)	.083
Ninety-day infection requiring RTOR	18 (0.4)	0 (0)	1 (0.1)	7 (0.4)	6 (0.6)	2 (0.6)	2 (2.1)	**.025**

Bolded values denote statistical significance of P ≤ .05.

Table 3
Results of post hoc Bonferroni.

Outcome	BMI cohort	*P* value
Thirty-day readmission		
Obese class III (6.2%)	Underweight (1.8%)	**.046**
	Normal (0.5%)	**<.001**
	Overweight (0.8%)	**<.001**
	Obese class I (0.9%)	**<.001**
	Obese class II (0.0%)	**<.001**

Bolded values denote statistical significance of P ≤ .05.

and hospital readmission, respectively, when compared against the normal BMI cohort. Surprisingly, we found that as age increased, it also increased the likelihood of a 30-day readmission, ED visit within 30 days, and ED visits within 72 hours.

Previous work has shown obesity to be a risk factor for 30-day readmission in total joint arthroplasty patients. [34,35] However, both these prior studies included all THA approaches and classified obesity as all patients with a BMI >30. Recently, Hartford et al. performed a BMI stratification study of 1808 primary DA THAs. The authors found BMI >40 to be associated with increased National Surgical Quality Improvement Program complications, surgical complications, wound breakdown, and deep infection. [32] Interestingly, the study did not see an increased risk of readmission in the BMI >40 cohort but rather in the underweight (BMI < 18.5) cohort. The increased rate of 30-day readmission in patients with BMI >40 is valuable data, as the average cost of readmission is over $17,000 in primary THA, imposing a significant cost to the healthcare system and potentially decreasing hospital reimbursement in today's bundled care payment models. [36]

We found an increase in 90-day infection requiring RTOR in the class III obese cohort (BMI > 40), as well as in the class I obese cohort (BMI = 30-34.9). This supported previously mentioned work by Hartford et al., which showed both increased wound breakdown and deep infection in patients with BMI >40. Similarly, Russo et al. showed an increased rate of wound complications in DA THA patients with obese patients (BMI > 30), Shevenell et al. demonstrated infection rates to be higher in class III obese patients (BMI > 40) than in healthy weight individuals (BMI = 18.5-25), Argyrou et al. used 172 matched pairs to display class III obese (BMI > 40) patients to be at increased risk for superficial wound infection when compared to nonobese patients (BMI < 30); and Antoniadis et al. presented an increased rate of RTOR in severely obese patients (BMI > 35), stating this was "mostly due to wound infection and dehiscence." [31,33,37,38] Purcell et al. found patients with BMI >35 to have a higher rate of deep infection and wound complications with both DA and posterior approach THA. Notably, they found the posterior approach to be protective against wound complications when compared to DA in patients of normal weight, but not in obese patients. [30] It should be noted that, of the 4767 patients in our study, there were only 18 infections requiring RTOR (0.38%), and this rate is lower than those reported in other studies. [31,33,38]

There was only a 0.21% (10/4767) incidence of intraoperative fracture in our population, and the fracture rate was shown to be increased in underweight patients at 1.8% (1/55). Admittedly, a low number of underweight patients in our study (n = 55) may have magnified the statistical significance of a single intraoperative fracture, but low BMI has previously been shown to be associated with intraoperative fracture in DA THA. [39] Prior studies have not shown a significant increase in fracture rate in obese patients undergoing DA THA, which is supported by our findings. [32,37,40] Although prior work by Di Martino et al. showed no difference in safe acetabular component inclination and Antoniadis et al. showed no difference in acetabular inclination/version and leg length in obese DA THA patients, this was not factored into our analysis, and

Table 4
Results of logistic regression.

Dependent variables	30-D readmission	90-D readmission	ED visits <30 d	ED visits ≤72 h	ED visits <7 d	Intraoperative fracture	90-D infection requiring RTOR
Age	1.035 [0.999-1.072]	1.044 [0.955-1.140]	**1.046 [1.022-1.071]**	**1.041 [1.009-1.073]**	1.038 [0.998-1.080]	1.059 [0.988-1.134]	0.968 [0.928-1.009]
Sex	0.572 [0.290-1.129]	0.387 [0.069-2.159]	0.742 [0.480-1.148]	0.931 [0.574-1.835	2.008 [0.970-4.157]	1.603 [0.401-6.405]	0.382 [0.134-1.084]
ASA	1.379 [0.716-2.655]	1.059 [0.212-5.186]	1.209 [0.793-1.845]	1.109 [0.630-1.953]	1.62 [0.832-3.154]	0.370 [0.094-1.457]	**2.907 [1.176-7.185]**
LOS	**1.732 [1.399-2.144]**	1.243 [0.697-2.216]	**1.684 [1.413-2.006]**	**1.436 [1.182-1.744]**	0.678 [0.402-1.145]	**1.540 [1.10-2.149]**	1.168 [0.785-1.736]
Underweight (BMI < 18.6)	3.735 [0.452-30.899]	NV	NV	NV	1.733 [0.225-13.363]	**13.120 [1.172-146.930]**	NV
Normal (BMI = 18.6-24.9)	Reference Category	Reference Category	Reference Category	Reference Category	Reference Category	Reference Category	Reference Category
Overweight (BMI = 25-29.9)	1.531 [0.616-3.804]	NV	0.623 [0.376-1.033]	0.600 [0.304-1.184]	0.456 [0.199-1.044]	2.295 [0.463-11.389]	5.363 [0.659-43.635]
Obese class I (BMI = 30-34.9)	1.821 [0.676-4.906]	NV	0.911 [0.529-1.567]	0.890 [0.430-1.841]	0.750 [0.317-1.776]	0.705 [0.064-7.785]	**8.508 [1.023-70.779]**
Obese class II (BMI = 35-39.9)	NV	NV	0.498 [0.176-1.414]	0.674 [0.198-2.291]	0.569 [0.129-2.500]	NV	8.620 [0.779-95.349]
Obese class III (BMI > 40)	**13.3 [4.379-40.390]**	NV	0.424 [0.057-3.133]	NV	NV	NV	**29.853 [2.683-332.187]**

NV, no variation (no variation between cohorts and not reported in the analysis).
Values are written as odds ratio (95% confidence interval), normal used as reference for BMI logistic regression, and male used as reference for sex logistic regression. Bolded values denote statistical significance of $P \leq .05$.

future studies on this topic can add evidence for these findings. [33,40] Likewise, future research can match large cohorts or use a randomized controlled trial to investigate the extent to which closure techniques, dressing methods, drains, estimated blood loss, LOS, operative time, and negative-pressure wound therapy influence postoperative complications within the obese patient population undergoing a DA THA.

Limitations

Our study has limitations. First, given its retrospective nature, we were unable to collect patient-reported outcome data at different postoperative time points and compare it between cohorts. Additionally, this study did not assess outpatient clinic data; thus, superficial infections treated with oral antibiotics were likely not fully captured. Admittedly, the relatively low rate of complications at our institution entails that even in a sample size of nearly 5000 patients, the demographics of our patient population resulted in a relatively low number of patients who qualified as underweight (n = 55) or class III obese (n = 97). This may have led to decreased power in the assessment of cohort differences introducing the possibility of type 1 and 2 errors. While findings of infections requiring a RTOR were found to be significantly different between BMI cohorts, multiple closure methods, dressings, operative time, and the possibility of negative-pressure wound therapy could have had an influence on the prevalence of infection. Similarly, significant demographic differences between cohorts may have affected the interaction between BMI and the collected outcomes. Lastly, as all results were from a high-volume specialty hospital, there may be concerns about the generalizability of these results to other clinical settings.

Conclusions

We present early complications after primary THA via DA with outcomes stratified by BMI. Risk of 30-day readmission was increased in patients with a BMI >40 when compared individually to all other cohorts. Additionally, these patients had an increased rate of 90-day infection requiring RTOR. Arthroplasty surgeons can use these findings in shared decision-making with patients when discussing indications for DA THA.

A video abstract is available at https://doi.org/10.1016/j.artd.2025.101679#mmc1.

Conflicts of interest

S. Barnett receives royalty fees from DePuy Synthes Products, Inc. and OMNIlife science, Inc. and is a paid consultant for DePuy Synthes Products, Inc., Medical Device Business Services, Inc., and OMNIlife science, Inc. All other authors declare no potential conflicts of interest.

For full disclosure statements refer to https://doi.org/10.1016/j.artd.2025.101679.

CRediT authorship contribution statement

Evan R. Simpson: Writing – review & editing, Writing – original draft, Visualization, Validation, Investigation, Formal analysis, Data curation. **Parke Hudson:** Writing – review & editing, Writing – original draft, Supervision, Methodology, Investigation, Conceptualization. **Viraj Deshpande:** Writing – review & editing, Writing – original draft, Visualization, Validation, Methodology, Formal analysis, Data curation. **Sean Guerrero:** Writing – review & editing, Validation, Supervision, Software, Resources, Project administration, Methodology, Investigation, Formal analysis, Data curation. **Steven Barnett:** Writing – review & editing, Writing – original draft, Visualization, Validation, Supervision, Project administration, Methodology, Investigation, Formal analysis, Conceptualization. **Matthew P. Siljander:** Writing – review & editing, Writing – original draft, Visualization, Validation, Supervision, Project administration, Methodology, Investigation, Formal analysis, Conceptualization.

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