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Original Research

Patient Perception of Robotic-Assisted Total Joint Arthroplasty in a Hispanic Population

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A B S T R A C T

Background: Robotic-assisted orthopaedic surgery has become popular and widely available, mainly for total joint arthroplasty. However, there has been a persistent concern regarding access to robotic-assisted surgery and the utilization rate of total joint arthroplasty among minority groups. As an imperative effort to close the gap regarding health inequalities, we assessed the knowledge and perspective of Hispanics regarding robotic-assisted orthopaedic surgery.
Methods: A 28-item questionnaire was established to evaluate Hispanics' perceptions of robotic-assisted orthopaedic surgery. Participants answered questions about demographic features, knowledge about robotic-assisted orthopaedic surgery, and preferences regarding manual vs robotic-assisted procedures.
Results: A total of 580 questionnaires were analyzed in our study, with an average age of participants of 49.1 years. Only 44.2% of the participants were familiar with robotic-assisted orthopaedic surgery. Fifty-three percent of the respondents preferred robotic-assisted surgery over conventional procedures, with many participants believing that robotic-assisted surgery leads to better outcomes (54.7%) and faster recovery (53.1%).
Conclusions: Knowledge about specific factors such as clinical outcomes and costs may influence the perception and preference of Hispanics toward robotic-assisted orthopaedic surgery. Therefore, patient education may play a crucial role in the informed decision-making process in Hispanics when opting between robotic-assisted or traditional orthopaedic surgery.

Introduction

The development of robotic systems in orthopaedic surgery began in the 1980s as an effort to achieve consistent, reproducible component positioning in total joint arthroplasty (TJA), surpassing the capacities of human precision [1]. A technological movement based on the rationale that robotic systems provide more accuracy has been sustained by recent literature demonstrating more precise implant positioning in robotic-assisted TJA, especially for acetabular alignment [2-5]. However, the benefits of robotic-assisted orthopaedic surgery compared to manual techniques still need to be investigated. Several studies have suggested no significant difference in postoperative outcomes in TJA. In contrast, additional research has shown better results regarding implant positioning, deformity correction, and patient-reported scores in individuals who underwent robotic-assisted TJA [2-4,6-9]. These conflicting findings set the ground for more comprehensive studies to better understand the differences in clinical outcomes and patients' perceptions between these modalities.

Despite the early experimentation with robotic-assisted orthopaedic surgery, it was only in the last 10 years that this technology became popular and widely available [1]. Therefore, it is essential to understand the general population's knowledge and perception regarding the use and application of robotic-assisted orthopaedic

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surgery to promote an educated and harmonious integration of this technology in everyday orthopaedic practice. In this perspective and considering the increasing trend in robotic-assisted TJA, Pagani et al. conducted an online survey to explore the public's perceptions and beliefs regarding robotic-assisted TJA [10]. Their findings demonstrated that 75% of participants had heard of robotic surgery in orthopaedics, yet only 51.4% accurately understood the robot's role in the operating room [10]. Moreover, most respondents believed robotic-assisted TJA led to better outcomes than manual techniques [10].

Amid the advances in robotic-assisted orthopaedic surgery, health inequalities should not be overlooked. Many studies have raised concern regarding the persistent disparities in TJA utilization rates and postoperative outcomes based on race or ethnicity [11,12]. For example, Hispanics are less likely to undergo TJA yet experience higher rates of postoperative complications, hospital length of stay, nonhome discharges, and lower satisfaction levels when compared with Caucasian patients [12,13]. Similarly, evidence in different surgical specialties has highlighted the disparities in robotic surgery access and clinical outcomes based on socioeconomic status and ethnicity [14-17]. Therefore, considering the growing demand for TJAs and the rising tendency toward robotic-assisted surgery, exploring the knowledge and perception of minority groups seems like a crucial step to closing the gap regarding health inequalities.

The patient's knowledge and perceptions regarding robotic-assisted orthopaedic surgery in minorities such as Hispanics remain unknown. Thus, the primary objective of this study is to evaluate and gain insight into the knowledge and perspectives of Hispanics regarding robotic-assisted TJA. Additionally, the study aims to identify any influencing factors that could affect their preferences and decisions concerning robotic-assisted TJA.

Material and methods

A cross-sectional study was designed to evaluate the knowledge and perception of Hispanics regarding robotic-assisted TJA. The study population consisted of patients at multidisciplinary outpatient clinics encompassing surgical and nonsurgical specialties at a major tertiary medical center. Enrollment was voluntary and subjected to informed consent. The inclusion criteria were set for individuals aged 21 and older who identified as Hispanics and completed the survey after providing informed consent.

A 28-item questionnaire in the Spanish language was prepared based on the electronic survey developed by Pagani et al. for public assessment of perception regarding robotic-assisted TJA [10]. The research forms were distributed in the clinics for a study period of 2 months. In the clinic waiting area, the individuals were offered the opportunity to participate in the study after fully disclosing the study objectives, including risks and benefits. The questionnaire was provided to all the patients who gave consent with instructions to fill out the document and return it at the end of their visit. Research personnel were available to clarify any questions or concerns about the survey. Incomplete surveys or multiple participation attempts were excluded before statistical analysis.

The data evaluated in the questionnaire included demographic features (ie, age, gender, education level, marital status, employment in healthcare, annual income, primary health insurance, prior knowledge about robotics in surgery, and overall self-assessed health status). The rest of the questionnaire presented questions to gauge the participants' knowledge about robotic-assisted orthopaedic surgery and their preferences regarding manual vs robotic surgery. These responses were then compared to patient demographics to determine potential associations between patient factors and differing perceptions about robotic-assisted TJA.

Statistical analyses were performed using SPSS and Microsoft Excel software. Categorical variables were evaluated using Pearson's chi-square or Fisher's exact tests. A multivariate logistic regression model was used to determine factors independently associated with a preference for robotic-assisted TJA. These results were reported as adjusted odds ratios (ORs) with 95% confidence intervals (CIs). A P-value of <.05 was considered statistically significant. This study was approved by the institutional review board at our academic center.

Results

A total of 602 participants provided informed consent to participate in the study. After excluding incomplete surveys, 580 responses remained for analysis. The average age of participants was 49.1 years, with 30.7% being less than 40 years old and 69.3% being more than 40 years old. Among all respondents, 46.2% were male and 53.8% were female. Around 63.0% of the participants reported earning an income of less than $20,000. The demographics of the study population are presented in Table 1.

Less than half (44.2%) of the participants were familiar with robotic-assisted technology in orthopaedic surgery. However, 70.3% of participants accurately understood the role of the robot in the operating room. Participants familiar with robotic-assisted surgery learned about the technique through television (34.5%) and the internet (20%), most commonly. However, only some reported they

Table 1
Participants characteristics.

Participants characteristics Variable, n (%)	Respondents
Age (y)	
<25	46 (7.9)
25-40	132 (22.8)
41-60	248 (42.8)
>60	154 (26.6)
Gender	
Female	312 (53.8)
Male	268 (46.2)
Marital status	
Single	241 (41.6)
Separated/divorced	63 (10.9)
Married	258 (44.5)
Widowed	18 (3.1)
Annual income in US$	
<20,000	365 (62.9)
20,000-40,000	147 (25.3)
>40,000	68 (11.7)
Primary health insurance	
Private	216 (37.2)
Medicare	80 (13.8)
Medicaid	284 (49%)
Perceived overall health status	
Poor or fair	70 (12.1)
Good	335 (57.8)
Very good	105 (18.1)
Excellent	70 (12.1)
Highest education level	
Less than high school	32 (5.5)
High school	260 (44.8)
College degree	238 (41)
Graduate degree	50 (8.6)
Healthcare worker	62 (10.7)
When it comes to technology, what best describes you?	
I am skeptical of new technologies, and use them only when I have to	158 (27.2)
I am usually one of the last people I know to use new technologies	111 (19.1)
I usually use new technologies when most people I know do	142 (24.5)
I like new technologies and use them before most people I know	107 (18.4)
I love new technologies and am among the first to experiment with and use them	62 (10.7)

learned about robotic-assisted surgery through acquaintances (6.4%) or directly from their physician (4.8%).

Overall, 53.1% of respondents preferred robotic-assisted orthopaedic surgery over manual procedures, with many reporting that their preference was due to their belief that robotic-assisted surgery leads to better outcomes (54.7%), a faster recovery (53.1%), fewer complications (50%), and more surgical precision (67.8%). However, most participants (64.7%) preferred a high-volume surgeon using manual, nonrobotic techniques. Participants hesitated to cover extra costs (57.4%) or wait longer (56.6%) to undergo robotic-assisted orthopaedic surgery. The most common concerns regarding robotic-assisted surgery consisted of surgeons' lack of experience with the technology (29%), increased costs (24.7%), and the potential for robot malfunction (17.8%). When asked if hospitals that offered robotic-assisted surgery were superior to those that did not, 61.2% of participants believed there was no difference in hospital quality based on the availability of this technology. See Table 2.

Following multivariate analysis, being married (OR 1.94, 95% CI 1.35-2.78, $P = .0003$), having some knowledge (OR 2.33, 95% CI 1.65-3.29, $P < .0001$) in robotic-assisted orthopaedic surgery, or being very knowledgeable (OR 4.27, 95% CI 1.87-9.17, $P = .0002$) in robotic-assisted orthopaedic surgery, and having prior knowledge of robotic surgery obtained through a physician (OR 4.67, 95% CI 1.90-10.70 $P = .0003$), family or friends (OR 2.74, 95% 1.31-5.75, $P = .0087$), internet (OR 3.29, 95% CI 2.02-5.35, $P < .0001$), or television (OR 2.74, 95% CI 1.78-4.20, $P < .0001$) were independently associated with the preference for robotic-assisted TJA. In addition, an annual income of $20,000 to $40,000 (OR 1.53, 95% CI 1.04-2.23, $P = .032$) or greater than $40,000 (OR 2.43, 95% CI 1.39-4.25, $P = .0015$) was independently associated with the preference for robotic-assisted TJA as well. See Table 3.

Discussion

Considering the growing demand for TJAs and the rising tendency toward robotic-assisted surgery, gaining insight into patients' knowledge and perception of robotic-assisted orthopaedic surgery seems fundamental. Persistent health inequalities in TJAs (ie, utilization rates, postoperative outcomes) and the limited access to robotic-assisted surgery among minorities make the inclusion of underrepresented groups in evaluating knowledge and perception imperative. This study consisted of a questionnaire-based analysis of the knowledge and perceptions of robotic-assisted orthopaedic surgery among Hispanic patients. Generally, our results demonstrate that most participants were unfamiliar with robotic-assisted TJA.

In this Hispanic cohort, only 44.2% reported familiarity with robotic-assisted TJA, a stark contrast to Pagani et al.'s study, in which the familiarity rate among their multiethnic cohort was 70% [10]. This disparity can be partially explained by the survey distribution method, with online surveys comprising a more technologically knowledgeable population than in-person surveys. This phenomenon is evident in various studies conducted about robotics in general surgery, whose results are comparable to ours, detailing a general lack of knowledge and understanding of robotics after in-person questionnaire distribution [18,19]. Additionally, multivariate analysis in this study revealed that knowledge of robotics obtained through the internet was associated with higher odds of preferring robotic-assisted TJA, providing further evidence of how our patient population and survey distribution method offer a different view than online-based surveys.

An annual income of less than $20,000 was associated with a preference for manual TJA in this patient population. Participants were hesitant to cover extra costs to undergo robotic-assisted TJA. Since multiple studies have reported significantly higher costs associated with robotic-assisted TJA, including increased hospital charges, total intraoperative expenses, and longer operative time with increased operating room supply and personnel costs, these concerns must be tackled for a cost-effective widespread implementation of robotic surgery [20-22]. Hua et al.'s recent study on the cost-effectiveness of robotic total knee arthroplasty (TKA) in the Medicare-aged population revealed that robotic TKA is cost-effective for high-volume hospitals (>49 procedures per year) due to the reduction in revision rates and lower postacute care costs associated with the technology [23]. However, without concrete evidence demonstrating improved clinical outcomes in patients, the higher cost becomes a significant barrier against the widespread implementation of robotics. This can affect this technology's dissemination in low-income regions with a lower case volume.

Given the limited number of Hispanic respondents in previous studies [10], we aimed to survey a Hispanic population. Our demographic profile demonstrates similar features to the national average demographics of Hispanics from the US Census Data [24], except for income and age. Nonetheless, the observed age discrepancy can be explained by our inclusion criteria of participants' age ≥21. Consequently, our mean age surpasses the national average for Hispanics.

Surveying a group that closely resembles the average Hispanic community in the US is vital given the increasing Hispanic population in the US and reports of a significant rise in Hispanic patients undergoing total hip arthroplasty in recent years [25], a change from previous low rates of Hispanics undergoing TJA [26]. The surveyed population consisted primarily of low-income Hispanic individuals (62.9% with annual income <$20,000) with limited access to technology and varying insurance status, providing valuable insights distinct from the findings in Pagani et al. [10]. These factors could contribute to their lower familiarity with robotics in orthopaedics and consequently, their lower rates of considering TJA as a viable option [26].

A statewide database study by Naziri et al. demonstrated that robotic TKA had increased by 500% [27]. From 2008 to 2015, robotic TKA and total hip arthroplasty utilization rates increased significantly, from 4.3%-11.4% and 0.5%-5.2%, respectively [28]. Integrating robotic technology into joint replacement surgery has gained momentum among physicians, as demonstrated by a survey conducted by the American Association of Hip and Knee Surgeons, revealing that 33.8% have incorporated it into their practice [29]. In parallel, patient demand for robotic TJA has skyrocketed over the past decade, potentially contributing to this trend [30]. Nonetheless, a notable discrepancy persists between the general public's beliefs concerning robotic-assisted TJA and the present body of evidence available in the arthroplasty literature. As such, further studies that help us gain insight into patients' perceptions are needed to better predict future trends.

In this context, the current study evaluated the perceptions of robotic-assisted TJA within the Hispanic population. The results showed a clear bisection in patient preference, with 53.1% of participants favoring robotic-assisted TJA and the remaining 46.9% showing a preference for manual surgery. Hence, our findings suggest no overwhelming, definitive consensus in favor of one method or the other, indicating that the choice for robotic-assisted TJA remains a matter of personal decision-making influenced by multiple patient-specific factors and circumstances. Considering this, promoting community education emerges as a crucial aspect in empowering Hispanics to make well-informed choices regarding their decision for TJA. By addressing their needs and providing comprehensive information, healthcare professionals can better assist Hispanic patients in making well-informed decisions regarding their preferred method for TJA.

Table 2
Public perception of robotic-assisted orthopaedic surgery.

Public perceptions of robotic-assisted orthopaedic surgery						
Question/statement		Respondents, n (%)				
		Not at All Familiar		**Somewhat Familiar**		**Very Familiar**
Are you familiar with the use of robotic- assisted technology in orthopaedic surgery?		324 (55.9)		222 (38.3)		34 (5.9)
	TV	**Internet**	**Family/Friends**	**Doctor**	**Prior Surgery**	**Have not heard of it**
How have you heard about the use of robotic-assisted technology in orthopaedic surgery?	200 (34.5)	116 (20)	37 (6.4)	28 (4.8)	27 (4.7)	172 (29.7)
		Yes		**No**		
If you were to have orthopaedic surgery, would you prefer the use of robotic-assisted technology over a conventional manual approach?		308 (53.1)		272 (46.9)		
		Yes		**No**		**No Difference**
Have you been through robotic-assisted orthopaedic surgery?		15 (2.6)		565 (97.4%)		
Do you know anyone who has had robotic-assisted orthopaedic surgery?		88 (15.2)		492 (84.8)		
Do you think that the use of robotic- assisted technology leads to better results following orthopaedic surgery in general?		317 (54.7)		46 (7.9)		217 (37.4)
Do you think that the use of robotic- assisted technology leads to fewer complications during or after orthopaedic surgery?		290 (50)		74 (12.8)		216 (37.2)
Do you think that the use of robotic- assisted technology leads to less pain after orthopaedic surgery?		229 (39.5)		57 (9.8)		294 (50.7)
Do you think that the use of robotic- assisted technology leads to faster recovery after orthopaedic surgery?		308 (53.1)		52 (9)		220 (37.9)
Do you think that the use of robotic- assisted technology leads to more precision during surgery?		393 (67.8)		62 (10.7)		126 (21.7)
Do you think that the use of robotic-assisted technology increases the duration of surgery vs nonrobotic surgery?		70 (12.1)		368 (63.4)		142 (24.5)
Do you think that robotic-assisted technology is of higher cost compared to nonrobotic surgery?		404 (69.7)		74 (12.8)		102 (17.6)
Would you be willing to pay more to have robotic-assisted technology used during orthopaedic surgery?		247 (42.6)		333 (57.4)		
Would you be willing to travel further to have robotic-assisted technology used during orthopaedic surgery?		326 (56.2)		254 (43.8)		
Would you be willing to wait longer in order to have robotic- assisted technology used in your orthopaedic surgery?		252 (43.4)		328 (56.6)		
Do you think hospitals that offer robotic or computer-assisted technology during orthopedic surgery are better than those that do not?		194 (33.4)		31 (5.3)		355 (61.2)
		Low-volume surgeon with robotics		**High-volume surgeon with manual methods**		
Would you rather have surgery performed by a low-volume surgeon using robotic-assisted technology or a high-volume surgeon using conventional manual methods?		205 (35.3)		375 (64.7)		
Which option do you believe best describes the use of the robot during the robot during orthopaedic surgery?						
Surgeon controls the robot and instruments during surgery	408 (70.3%)					
Surgeon tells the robot what to do, and the robot follows orders	116 (20%)					
The robot performs the surgery and the surgeon waits for the robot to finish inside the operating room	40 (6.9%)					
The robot performs the surgery and the surgeon waits for the robot outside of the operating room	16 (2.8%)					
What would be your main concern regarding robotic-assisted robotic-assisted orthopaedic surgery?						
The surgery is of increased cost	143 (24.7%)					
The surgery is of longer duration	31 (5.3%)					
The inexperience of the surgeon with the use of robots	168 (29%)					
The lack of research regarding the use of robotics in surgery	135 (23.3%)					
Being harmed by the robot during the surgery	103 (17.8%)					

Table 3
Population characteristics associated with preference for robotic-assisted orthopaedic surgery.

Population characteristics associated with preference for robotic-assisted orthopaedic surgery					
Variable, n (%)	Decision for robotic surgery			Adjusted OR (95% CI)	*P* value
	No	Yes	*P* value		
Total	272 (46.9)	308 (53.1)			
Age (y)			.37		
<25	26 (9.56)	28 (9.09)			
25-40	66 (24.26)	58 (18.83)			
41-60	114 (41.91)	134 (43.51)			
>60	66 (24.26)	88 (28.57)			
Gender			.26		
Male	119 (43.75)	149 (48.38)			
Female	153 (56.25)	159 (51.62)			
Civil status			<.001		
Single	130 (47.79)	111 (36.04)		Reference	
Married	97 (35.66)	161 (52.27)		1.94 (1.35-2.78)	.0003
Divorced	35 (12.87)	28 (9.09)		0.94 (0.54-1.65)	8.87
Widow	10 (3.68)	8 (2.60)		0.94 (0.36-2.54)	>.9999
Educational level			.86		
Less than High school	16 (5.88)	16 (5.19)			
High school	126 (46.32)	134 (43.51)			
College degree	108 (39.71)	130 (42.21)			
Masters/Doctorate	22 (8.09)	28 (9.09)			
Annual income (US$)			<.001		
<20,000	190 (69.85)	175 (56.82)		Reference	
20,000-40,000	61 (22.43)	86 (27.92)		1.53 (1.04-2.23)	.032
>40,000	21 (7.72)	47 (15.26)		2.43 (1.39-4.25)	.0015
Primary health insurance			.36		
Private	216 (37.2)				
Medicare	80 (13.8)				
Medicaid	284 (49%)				
Health-care worker			.77		
Yes	28 (10.29)	34 (11.04)			
No	244 (89.71)	274 (88.96)			
Perceived health status			.95		
Poor	34 (12.50)	36 (11.69)			
Good	157 (57.72)	178 (57.79)			
Very good	47 (17.28)	58 (18.83)			
Excellent	34 (12.50)	36 (11.69)			
Prior robotic surgery knowledge			<.001		
No	184 (67.65)	140 (45.45)		Reference	
Some	80 (29.41)	142 (46.10)		2.33 (1.65-3.29)	<.0001
Very knowledgeable	8 (2.94)	26 (8.44)		4.27 (1.87-9.17)	.0002
Where have you heard about robotic surgery?			<.001		
Never heard	112 (41.18)	60 (19.48)		Reference	
Physician	8 (2.94)	20 (6.49)		4.67 (1.90-10.70)	.0003
Hospital	14 (5.15)	13 (4.22)		1.73 (0.76-3.86)	2.01
Family/friends	15 (5.51)	22 (7.14)		2.74 (1.31-5.75)	.0087
Internet	42 (15.44)	74 (24.03)		3.29 (2.02-5.35)	<.0001
Television	81 (29.78)	119 (38.64)		2.74 (1.78-4.20)	<.0001

Our study presented some limitations. First, since it is a questionnaire-based study, answers may be subject to response bias. Secondly, patients were given surveys while waiting for healthcare appointments, possibly introducing selection bias since these participants undergoing healthcare visits may be inclined to have more knowledge about robotic surgery than the general population. Lastly, we used a nonvalidated questionnaire, which could limit the accuracy of the responses. Nevertheless, we addressed an emerging topic with limited literature and research tools. Future studies could expand the scope of our research, exploring aspects such as barriers to accessing and affording robotic technology among Hispanics and conducting cross-cultural comparisons to provide a broader perspective on the subject.

Conclusions

This study evaluated the perception of robotic-assisted TJA in a Hispanic population. We observed no absolute consensus between robotic-assisted and manual TJA. Deciding between these treatment modalities remains a comprehensive task primarily influenced by knowledge, perception, and other patient-specific factors. Therefore, education could play a crucial role in the informed decision-making process by Hispanics when opting between robotic-assisted and manual TJA.

CRediT authorship contribution statement

Marcantonio V. Pinci: Conceptualization, Data curation, Formal analysis, Investigation, Methodology, Supervision, Visualization, Writing – original draft, Writing – review & editing. **Norberto J. Torres-Lugo:** Conceptualization, Data curation, Formal analysis, Investigation, Methodology, Supervision, Validation, Visualization, Writing – original draft, Writing – review & editing. **David E. Deliz-Jimenez:** Data curation, Formal analysis, Methodology, Visualization, Writing – original draft, Writing – review & editing. **Joseph Salem-Hernandez:** Data curation, Formal analysis, Investigation, Methodology, Writing – original draft. **Alexandra Claudio-Marcano:** Conceptualization, Investigation, Methodology, Supervision, Writing – original draft, Writing – review & editing. **Norman Ramírez:** Conceptualization, Data curation, Formal analysis, Investigation, Methodology, Supervision, Visualization, Writing – original draft, Writing – review & editing. **Antonio Otero-López:** Conceptualization, Formal analysis, Investigation, Methodology, Supervision, Validation, Visualization, Writing – original draft, Writing – review & editing.

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Conflicts of interest

The authors declare there are no conflicts of interest.

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