

Operating room turnover times for radical prostatectomy: a single center retrospective comparison between multimodular and single-boom robotic systems

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Background: The introduction of multimodular robotic platforms has raised concerns regarding operating room (OR) efficiency compared to established single-boom systems. This issue is particularly relevant in high-volume robotic programs, where OR turnover time (ORTT) represents a key determinant of productivity and cost-effectiveness. The aim of this study was to compare OR turnover time and closure-to-incision time between a multimodular robotic system (Hugo™ RAS) and a single-boom system (Da Vinci® Xi) during robot-assisted laparoscopic radical prostatectomy in a standardized, high-volume setting.

Methods: We conducted a single-center retrospective cohort study comparing ORTT and closure-to-incision time (CTIT) between the Da Vinci® Xi and Hugo™ RAS systems in robot-assisted laparoscopic radical prostatectomy (RALP). Only homogeneous OR sessions exclusively dedicated to RALP and performed by a stable, experienced robotic team were included.

Results: A total of 84 turnovers were analyzed (32 Da Vinci Xi and 52 Hugo RAS). Baseline patient characteristics were comparable between groups. Median ORTT was 45.5 min for Da Vinci Xi and 49.0 min for Hugo RAS ($p = 0.139$). Median CTIT was 99.0 and 93.5 min, respectively ($p = 0.813$).

Conclusions: In a standardized, high-volume setting, the multimodular architecture of the Hugo RAS system does not result in significantly longer OR turnover times compared to the Da Vinci Xi. Institutional factors such as team experience and workflow standardization appear to outweigh platform-specific technical differences in determining OR efficiency.

Key Words: robot-assisted radical prostatectomy, operating room efficiency, turnover time, multimodular robotic systems, surgical workflow, cost optimization

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Introduction

Robotic-assisted surgery has revolutionized the field of urology, particularly for procedures like radical prostatectomy, by enhancing precision,

reducing invasiveness, and improving perioperative outcomes.¹ For over two decades, the Da Vinci[®] Surgical System has dominated the robotic surgical landscape, with extensive data supporting its efficacy and safety. However, the expiration of core patents and the growing demand for potential cost-effective solutions have paved the way for the emergence of new robotic platforms.^{2,3} Among these new systems, several—including the Hugo[™] RAS (Medtronic), Versius[®] (CMR Surgical), and Carina[™] (Ronovo Surgical)—have introduced a multimodular approach to robotic surgery.^{4,5} Unlike the single-boom design of Da Vinci, these platforms feature independent robotic arm carts that are positioned individually around the operating table. While this modularity offers advantages in terms of physical flexibility and portability, it also raises concerns about increased setup complexity, longer OR preparation times, and potential inefficiencies in operating room (OR) logistics.^{6,7}

In this context, the Hugo[™] RAS system has emerged as a widely adopted platform, particularly in urologic surgery.^{4,8,9} Previous studies have reported longer docking times compared with the Da Vinci[®] Xi during the early phase of system implementation, an effect primarily attributable to the performance of the unsterile scrub nurse during positioning of the patient carts.¹⁰ Its architecture requires meticulous coordination for the docking and undocking of multiple components, which may affect the turnover time between consecutive cases—a critical metric of OR efficiency. Operating room turnover time (ORTT), defined as the interval between the exit of one patient and the entry of the next, plays a major role in surgical scheduling, institutional throughput, and overall cost-effectiveness.^{11,12} Importantly, emerging evidence suggests that the potential workflow drawbacks associated with the multimodular design of the Hugo[™] RAS system may be mitigated by team adaptation and experience, for example experienced robotic nurses rapidly develop compensatory strategies when transitioning to the Hugo RAS platform, restructuring task allocation, spatial organization, and timing of setup activities to preserve efficiency despite increased technical complexity.^{13,14}

Despite the increasing use of Hugo RAS, real-world data on its impact on intraoperative workflow, especially in comparison to established systems like Da Vinci, remain limited. To address this gap, the present study retrospectively compares OR turnover times between Hugo and Da Vinci systems in a high-volume robotic program. By focusing on robot-assisted radical prostatectomy (RALP)—a highly standardized urologic procedure—we aim to isolate

the influence of robotic platform architecture on OR efficiency while controlling for procedural variability.

Methods

Study design

This study was designed as a single-center retrospective cohort analysis comparing operating room (OR) efficiency metrics between two robotic platforms—the Da Vinci[®] Xi Surgical system (Intuitive Surgical Inc., USA) and the Hugo[™] RAS Surgical systems (Medtronic plc, Ireland)—during robot-assisted laparoscopic radical prostatectomy (RALP). The study was conducted at Fondazione Policlinico Gemelli IRCCS, Rome, Italy, a tertiary referral center with an established high-volume robotic surgery program, equipped with the Da Vinci, Hugo RAS, Versius, and Toumai. The Da Vinci was introduced in 2013, and Hugo RAS by the end of 2022.

Study setting and operating room organization

The database was queried to extract intra-operative data from RALP procedures performed either within the same working day (whole-day session, 8:00 am to 8:00 pm) or within the same 6-h robotic slot (single session, defined as 8:00 am to 2:00 pm or 2:00 pm to 8:00 pm). Each whole-day session or 6-h slot included different RALP procedures carried out on the same robotic platform (Da Vinci Xi or, alternatively, Hugo RAS). To minimize potential bias related to the learning curve associated with the introduction of the Hugo RAS system in late 2022, only RALP procedures performed from 2024 onward were included in the analysis. Turnover was performed with exactly the same staff numbers.

Patients were positioned according to the robotic platform used: a dorsal lithotomy position combined with steep Trendelenburg was adopted for procedures performed with the Hugo RAS system, for the presence of a chart between the legs, whereas a supine position combined with steep Trendelenburg was used for procedures performed with the Da Vinci Xi system. In all cases, dedicated patient support systems or non-slipping devices were employed to prevent cranial migration during surgery, and arterial line insertion was performed. Robot draping was carried out after patient positioning and completion of anesthetic a-line insertion and induction, in accordance with a standardized institutional protocol and prior to docking.

All procedures were performed by experienced robotic surgeons assisted by a dedicated operating room team with a stable composition, including

anesthesiologists, nurses, and surgical technicians. Staffing levels and role allocation during turnover phases remained consistent throughout the study period.

Study population

The study cohort consisted of a total of 84 turnovers analyzed during the study period. Of these, 32 (38.1%) were performed within Da Vinci Xi sessions, and 52 (61.9%) were performed within Hugo™ RAS sessions. To ensure a robust comparison and minimize potential selection bias, the baseline characteristics of the patients in both groups were meticulously evaluated. The two study populations were found to be highly comparable, with no statistically significant differences in terms of key anthropometric and clinical variables.

All patients signed a comprehensive informed consent for data collection; baseline, demographic, clinical, surgical, and radiological variables are recorded in a prospectively maintained database developed for the purpose of internal audit and individual outcome analysis. This study was conducted in accordance with the Declaration of Helsinki and was approved by the Institutional Ethics Committee of Fondazione Policlinico Gemelli IRCCS, Rome, Italy (IRB approval number: 5119/2022). Written informed consent for data collection and analysis was obtained from all participants prior to surgery.

Outcomes and statistical analysis

The following variables were extracted: (1) demographic and clinical data (age, BMI, ASA score); (2) operative time (OT, from incision to closure, min); (3) time from skin closure to incision time (CIT) (from skin closure to the last patient to incision of the new patient); (4) OR turnover time (ORTT) defined as the interval between the exit of the patient from the OR and the entering of the next (min).

The primary endpoint is to compare CIT and ORTT between OR sessions performed with Da Vinci and Hugo RAS. The outcome measure is the time expressed in minutes.

A descriptive analysis of all variables was performed. The Shapiro-Wilk test was utilized to assess the distribution of continuous variables. Because the temporal data (ORTT and CIT) exhibited a non-normal distribution ($p < 0.05$), results are reported as medians and interquartile ranges (IQR) rather than means to provide a more accurate representation of central tendency. Comparisons between the Da Vinci Xi and Hugo RAS groups were conducted using the independent samples *t*-test or the Mann-Whitney U test, as appropriate. Categorical variables were

assessed using the chi-square test. All analyses were performed using Stata 18 (StataCorp LLC, College Station, TX, USA) for macOS.

Results

Overall, an amount of 84 turnovers were considered, 32 (38.1%) within Da Vinci and 52 (61.9%) within Hugo RAS sessions. Baseline characteristics of patients included in each turnover were similar between groups (age, BMI, and ASA scores, *p*-value of the latter 0.056). Time from skin closure to next incision was similar (99 and 93 min for Da Vinci and Hugo RAS, respectively), as well as OR turnover time (45 and 49 min for Da Vinci and Hugo RAS, respectively). [Table 1](#) summarizes all major findings. The median was chosen instead of the mean because the distribution of the analyzed variables was non-normal and skewed, with the presence of outliers. Under these conditions, the median provides a more robust and representative measure of central tendency, as it is less influenced by extreme values.

Discussion

With the advent of new robotic platforms, different features have been deeply analyzed, including clinical outcomes, hospital/OR setup, and cost-effectiveness. The operating turnover time has never been addressed before, especially with regard to the comparison between multimodular versus single-boom robotic configurations. This study shows that both closure-to-next-incision time and OR turnover time are comparable between the Hugo™ RAS and Da Vinci® Xi systems, with a modest, statistically nonsignificant increase observed for Hugo. These findings challenge the notion that multimodular robotic platforms, such as Hugo, necessarily result in inferior OR efficiency due to increased setup and docking complexity.⁷

The Hugo system, along with other newer robotic platforms like Versius® and Carina™, employs a modular cart-based configuration, which may demand more coordinated room setup. However, in our high-volume academic and private setting—where OR teams had prior robotic experience and underwent structured transition training—this architectural difference did not translate into a significant delay in workflow. Our decision to conduct this study within such a highly standardized, mature robotic program was a deliberate methodological

TABLE 1. Summarizes major findings (ORTT and CIT)

Variables	DaVinci sessions	Hugo sessions	Total	<i>p</i> -value
N (percentage)	32 (38.1%)	52 (61.9%)	84 (100.0%)	
Age at surgery, Mean (SD)	65 (8)	66 (6)	66 (7)	0.563
BMI (kg/m ²), Mean (SD)	26.5 (3.5)	25.8 (3.2)	26.1 (3.3)	0.371
OR TT (minutes), Median (IQR)	45.5 (18.0)	49 (16.0)	46.5 (16.5)	0.139
Time from skin closure to incision (minutes), Median (IQR)	99.0 (27.5)	93.5 (18.0)	94.5 (25.0)	0.813

Note. Continuous variables were summarized as mean and standard deviation (SD) or median and Interquartile range (IQR), depending on the distribution assessed by the Shapiro-Wilk test. Comparisons between groups were conducted using the independent samples *t*-test or the Mann-Whitney U test, as appropriate.

Abbreviations: ORTT, Operating Room Turnover Time; CIT, Closure to Incision Time; ASA, American Society of Anesthesiologists.

choice aimed at isolating the “robotic platform” variable. By minimizing the “noise” associated with staffing fluctuations or learning-curve inefficiencies, we were able to observe the mechanical and architectural impacts of the platforms in a near-ideal environment. While these results represent a “best-case scenario”—effectively serving as a benchmark for mature programs rather than a universal standard—they underscore that institutional experience, standardization of procedures, and cohesive team dynamics play critical roles in mitigating logistical inefficiencies during platform transitions.^{11,12}

While this study focused on OR turnover time, the broader economic implications of adopting new robotic platforms are complex and multi-factorial. Surgical robotics costs extend beyond the initial capital investment and include consumables, maintenance, staffing, and crucially, OR time. Recent work by Landi et al.¹² employed a time-driven activity-based costing model within a value-based healthcare framework to demonstrate that OR time is one of the primary cost drivers in robotic procedures—often outweighing equipment acquisition costs themselves. From this perspective, even moderate differences in ORTT and operative time can have measurable financial consequences, especially in high-throughput centers.^{12,15} Similarly, Sighinolfi et al.¹⁶ in their comparative cost analysis of robotic platforms, emphasized how procedural efficiency, turnover times, and case volumes directly influence per-case cost across different robotic systems.¹⁶ In this context, our data showing comparable turnover times suggests that the Hugo RAS platform may maintain operational cost-efficiency when deployed in structured clinical environments with well-trained teams. Consistent with our findings, Hirtsiefer et al.¹⁷

recently reported on how, at the very beginning, Hugo RAS could be less time-efficient than Da Vinci; however, with a prospective single-center study, the authors found that the gap closes after approximately 15 procedures, with a persisting small Hugo disadvantage for the “system preparation” step.

Limitations

Despite the insights provided regarding operating room efficiency, several limitations of this study warrant careful consideration. First, the retrospective, single-center design conducted at Fondazione Policlinico Gemelli IRCCS—a high-volume tertiary referral center—may limit the generalizability of our findings to institutions with different clinical volumes or organizational structures. Our outcomes were achieved in a highly standardized environment supported by an exceptionally stable robotic team, including anesthesiologists and surgical technicians with extensive experience. Consequently, centers with lower robotic throughput, inconsistent staffing, or less robust training infrastructure might encounter different logistical challenges when managing the multimodal architecture of the Hugo™ RAS system.

Another significant limitation is the absence of a formal cost analysis. While our study focused on temporal metrics (ORTT and CTIT). Without a dedicated time-driven activity-based costing (TDABC) model, the full economic impact of the platform’s modularity remains partially unaddressed in this analysis. Finally, although Schouten et al.¹¹ emphasize the importance of comprehensive performance metrics, our study did not evaluate long-term functional or

oncological outcomes. Therefore, future prospective multicenter investigations are required to integrate efficiency metrics, advanced cost modeling, and institutional variables to evaluate the comprehensive value proposition of emerging robotic platforms in diverse clinical settings.

Conclusions

In a high-volume, highly standardized robotic surgery hospital, the multimodular architecture of the Hugo™ RAS system does not translate into a significant loss of operating room efficiency when compared with the single-boom Da Vinci® Xi platform. Both operating room turnover time and closure-to-incision time were comparable between systems, indicating that concerns regarding increased logistical complexity with multimodular robotic configurations may be overstated when procedures are performed by experienced teams within optimized workflows.

These findings underscore the pivotal role of institutional factors—such as team expertise, procedural standardization, and organizational maturity—in determining operating room efficiency, often outweighing platform-specific technical differences. From an operational and managerial perspective, the ability of a multimodular robotic system to maintain turnover times comparable to an established platform suggests that its adoption can be compatible with high-throughput surgical models, without compromising productivity.

Nevertheless, the single-center and retrospective design of this study limits the generalizability of the results. Further prospective, multicenter investigations are warranted to determine whether these findings can be reproduced in different health-care settings, particularly in non-tertiary hospitals, lower-volume centers, and institutions with limited prior experience in robotic surgery, where workflow standardization and team familiarity may differ substantially.

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Author Contributions

Conceptualization and study design: Maria Chiara Sighinolfi, Bernardo Rocco. Data curation: Giuseppe Pallotta, Simona Presutti, Antonio Silvestri, Simone Assumma. Formal analysis: Stefano Terzoni. Investigation: Giuseppe Pallotta, Maria Chiara Sighinolfi, Ela Patel, Simona Presutti, Antonio Silvestri, Daniele Fettucciari, Vincenzo Cavarra, Filippo Gavi, Giovanni Filomena, Francesco Rossi, Domenico Varacalli, Marco Montesi, Nicoletta Testori, Arianna Del Proposto, Stefano Abed, Enrico Panio. Methodology: Maria Chiara Sighinolfi, Bernardo Rocco, Giuseppe Pallotta. Writing: Giuseppe Pallotta, Maria Chiara Sighinolfi. Supervision: Bernardo Rocco. All authors reviewed and approved the final version of the manuscript.

Availability of Data and Materials

The data presented in this study are available on request from the corresponding author.

Ethics Approval

This study was conducted in accordance with the Declaration of Helsinki and was approved by the Institutional Ethics Committee of Fondazione Policlinico Gemelli IRCCS, Rome, Italy (IRB approval number: 5119/2022). Written informed consent for data collection and analysis was obtained from all participants prior to surgery.

Conflicts of Interest

The authors declare no conflicts of interest.

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