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Original Article

The role of robotics in enhancing surgical precision and efficiency in general surgery

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Abstract

Background: *Thus, robotic systems have been introduced into the general-surgical practice in order to address the hurdles of the traditional surgery approach. Robotic surgery technology is more enhanced as compared with conventional technology in the aspects such as HD 3D vision and manoeuvrable instruments, which have yield better results for the patients.*

Aim: *This paper aims at analysing the application of robotics in increasing accuracy and speed in general surgery with the strengths, weaknesses, and implication to surgical practice considered.*

Methods: *While reviewing the evidence from the clinical trials, case reports and surgeons' experience, the authors' examined the use of robotics generally and the da Vinci Surgical System in particular in general surgery. To describe the changes in the aspect of surgical accuracy, time, complications and patients' condition, data were obtained from different sources such as hospitals. scientific comparisons and comparative cross sectional regression analyses were used to ascertain the outcomes.*

Results: *It was established that the application of robotic surgeries led to the decrease of the number of mistakes by 0. 5 mm ± 0. 5 µm as against 1 µm is the usual range of accuracy that is achievable between two parallel surfaces. 2 mm ± 0. 4 mm in conventional techniques ($p < 0.01$). Further, robotic surgeries were shown to have better outcomes in terms of operative time, which was reduced and the complications recorded were at 5% ± 1. 5% as compared to 10% ± 2% in laparoscopic surgeries ($p < 0.01$). Similarly patient satisfaction and especially the long-term results, especially regarding oncological procedures, were enhanced.*

Conclusion*: The application of robotics has enhanced general surgery by enhancing precision and reducing surgical time hence raising the quality of individual patient care and duration of stay. Though, there are still drawbacks like high cost of robotic system, time taken by surgeons to become proficient with the robotic system, constant improvement of robotic technology augments surgical practices in a sense that makes robotic assisted surgery an important tool in health care delivery system.*

Keywords: *Robotic surgery, surgical precision, efficiency, general surgery, da Vinci Surgical System, patient outcomes, surgical technology.*

Introduction

Robotics in surgery can be regarded as one of the most important innovations within the recent years, changing the field of surgery. The use of robotics in surgery started earlier 1980s, when first robotic systems like PUMA 560 were used in biopsies of the brain. These early systems created a foundation for the platforms to progress forward to the introduction of the da Vinci Surgical System in the year 2000; this system is already the most prevalent robotic surgical system in the world [1]. The da Vinci system enables the surgeon to see, manipulate and control as never before giving Intuitive Surgical's system the ability to help surgeons become more precise during minimally invasive surgical procedures. This advancement has led to rather swift incorporation of robotics in numerous fields of surgery with general surgery being one of them [2].

General surgery, a branch that is characterised by the versatility that it offers, has in the past been considered to be fraught with problems. Some of the problems are about delicate accuracy, intricate shapes of human bodies, and sufficient intraoperative methods to avoid postoperative such issue as morbidity and mortality. While conventional treatments of surgery have been known to yield optimum results, they are marked by large and extensive invasive surgeries, long recovery periods and high probabilities of developing complications. Conventional open surgery that dominated most operative interventions in the earlier part of the 20th century has some severe drawback though: the postoperative mortality, median stay at the hospital, and slow healing times [3]. Still, as with any minimally invasive treatment, there are inherent disadvantages as to the accuracy that the surgeon can provide and the ability to reach various parts of the anatomy. Such shortcomings have encouraged search for alternative ways to apply robotics in surgery leading to general surgery application [4].

Robotic surgery helps to overcome the most significant problems occurring in general surgery by increasing accuracy and effectiveness of the operations. Radicality in surgery is critical that a slight deviation from the normal track may result in a severe adverse reaction that may have effects on surrounding structures such as tissues, blood vessels or nerves. Robotics bring about higher accuracy through the use of attached tools that mimic the human hand with more flexibility and an increased width of operational angle [5]. They may be utilized in small fields with a degree of precision that has not been attainable with conventional laparoscopic devices. Finally, robotic systems gives the surgery better and clear visuals, high definition 3D vision as opposed to the conventional 2D view which enhances the identification of vital anatomical structures and enhances the manner and precision the surgery uses to suture the body [6].

Surgical productivity is of similar significance, since it affects the results of the task as well as the efficiency of medical work. There are surgeon indexes that can be minimized, such as the time of surgery, amount of blood loss, or the length of stay in hospital. 'Automated' helps increase efficiency through increasing the speed at which complicated procedures can be done with less complications. For example, higher accuracy of robot manipulators decreases intraoperative mistakes and can be a reason for less operations' time and blood loss. In addition, because most robotic surgery is less invasive than traditional open surgery, wound sizes are generally reduced, and patients experience less pain and therefore shorter hospitalization and, therefore, lower costs [7].

Precision and efficiency are factors that touch directly on patients' lives and are as important as the detected diseases and illnesses. Surgical accuracy has been found to decrease the level of complications such as infection, haemorrhage and injury to structures that may be essential. In this manner, potential risks associated with the technique are reduced to a minimum, and the successful outcome is more likely to be achieved by the patient. For example, in the case of colorectal surgery, studies with the use of robotic systemivity: It has been found that values of anastomotic leak, a severe complication where the join of two segments of the intestine do not heal, decreased significantly. Furthermore, enhanced accuracy of the surgery in liberation of tumors during oncologic procedures translates to likelihood of attaining negatives margins and therefore enhanced chances of minimizing cancer relapse [8].

On the other hand, efficiency is to work as an essential component in the process of utilisation of health care resources and enhancing the satisfaction levels of the patients. In addition to providing cost

savings to healthcare consumers and facilities, shortened operative times and therefore, length of stay, add value to the patient experience. Robotic surgery allows patients to have minimal postoperative suffering, short time in returning to normalcy and high levels of satisfaction regarding their surgery. This is especially so by the time patient-cantered care has become the norm with providers being judged on patient satisfaction indices and success.

All the same, it is useful to look at the various disadvantages and problems that come with robotic surgery. A major limitation of the use of robotic systems is the cost involved which may be a big put off to most healthcare organizations. The start-up costs that come with acquiring a robotic system, the annual recurring costs of servicing and supply of the instruments, may impose incredible demands on a hospital's resources especially in the developing countries. Furthermore, it has been seen that there is a rather steep gradient for surgeons who have to switch from a conventional open or laparoscopic surgery technique to make use of robotic techniques. The robotic console is complex, and the surgeon is often very much involved in a given robotic operation; therefore, the expertise of the surgeon highly influences the success of robotic operations.

Further, while the surgery has the benefits of being more precise and faster as the surgeon directs the robotic arm, the surgery has the following risks. However, they are rather rare and still may cause some problems, for example, delays in operations, during surgeries. In addition, questions have been tied to the notion of reduced surgeon control together with reliance on robotic systems. Thus, admit the need for the constant assessment and enhancement to avoid stagnation of the robotic surgery, thus, serving the purpose of patients and healthcare givers [9].

Therefore, the use of robotics in general surgery has revolutionized the profession by providing a new effective tool that improves results achieved in operations. Thus, the use of robotic systems would be a best way to avoid many of the difficulties which are inherent in classic surgical interventions, especially in the given field of maximal and minimal invasiveness. But in this case the extensive usage of the robotic surgeries requires such measures as cost, availability, training and assessment for performance. With advancement in technology, expect that robotic systems will be more integrated in the general surgery practice as this will foster the advancement of methods that will lead to efficient practices in surgeries. In this article, the author shall seek to explain and discuss the various ways through which robotics improves the precision and effectiveness of general surgery, including the pros and cons of this emerging innovation.

Materials and Methods

Over the last decade, robotics surgery has been introduced into general surgery because of the advancement of new improved systems that augment the surgeons' abilities. Of these systems, the da Vinci Surgical System stands out as the most popular and is used interchangeably with robotic surgery since it is the most utilized type. The da Vinci system is composed of three primary components: the surgical console, the patient side cart with the robotic arms and the vision system. The surgeon's platform enables the surgeon to manipulate all the robotic arms and instruments from a distance by hand and feet. The arms themselves are mounted on what is termed the patient-side cart and they avail themselves of the end effectors to grip and move surgical instruments in a capacity beyond human control. It is known to present real time operative view to the surgeon and in high definition, three dimension to ensure the operating procedures are well done [10].

Surgical robots are, therefore, programs that mirror and amplify the performance of the human hand in the operating room and integrate capabilities that would not be available with the naked hand. Another aspect of robotic systems for instance the da Vinci is the ability to control articulated instruments as a means of having a wider degree of freedom as compared a rigid band. These instruments can swivel and flex in a way that can only be done by machinery, thus offering the surgeon precisely manoeuvred use in tight spaces and tasks. Moreover, control of the robotic systems is relatively easy and the movements of end-effector arms can be easily balanced to the surgeon's hand

movements. This smooth working of the surgeon with the robotic system is important so that the flow of the surgery does not get interrupted and at the same time improves the function and movement of robotic hands.

There is also a feature which applies the approach of three-dimensional visualization in the sphere of surgical robots. For example, the da Vinci system enables the surgeon to have a better view of the surgical site through a 'HD 3D' view which is very different from the two-dimensional view offered by the common laparoscopic cameras. This in turn offers a superior view of such structures which makes dissection as well as suturing a lot easier. In addition, there are some types of robotic systems that use haptic feedback to simulate sensations of touch by offering tissues some levels of stiffness or inducing vibrations into the instruments used by the robotic systems. Although the integration of haptic feedback is still in a relatively infancy stage in the field of robotic surgery, it presents the possibility of improving surgeon's performance in operating on substantially sensitive tissues without causing any harm [11].

The approaches that can be used for the assessment of robotic systems and their effect on general surgery are fundamentally based on clinical trials, retrospective studies, and systematic review of the literature. These works may be carried out to compare the results of robotic surgical procedure with laparoscopic or open surgery counterparts for certain surgery. These trials are in some cases done to compare factors including time taken to perform the operation, amount of blood shed, rate of complications, and the pace at which patients recover. On the other hand, there are case-control studies which entail finding and comparing patients' record as well as hospitals' surgical results of patients who have undergone robotic surgery. The proposed formal analyses offer the important data for the assessment on the efficiency and safety of robotic systems on the longer term. Systematic review of such literature is also done to make synthesis of the findings from multiple works and to provide an overview of the current scenario of the use of robotic surgery along with the research gaps that need to be filled [12].

There are often specific criteria related to the choice of the studies or data sets regarding robotic surgery, which makes the data robust. For example, meta-analysis might have requirements on the type of studies that are included in a literature review, only randomized control trials or very large case control studies for example. Also, the studies used should centre on general surgery operations that incorporate use of robot, for example the colorectal surgery, cholecystectomy, or hernia surgery. Any study with small subject population, which is not placebo-controlled, or which addresses procedures other than general surgery may be excluded. In this way, by applying such criteria to choose the studies, the researchers will be able to provide only the best evidence for the analysis.

The methods of acquiring the data which is to be used in the context of the evaluation of robotic surgery include securing information from a number of sources. Medical trials are considered should be listed as the primary kinds of evidence since they give prospective, controlled information on the efficiency of robotic surgery. These trials sometimes quantify reasonable end results such as the accuracy of resections in surgery, complications prone to occur and the time taken for patients to recover. Finally, case-studies are another form of data and particularly important when the procedure has been complex or novel and robotic systems have been employed. Personal case studies describe individual operations and discuss how and where robotic surgery is beneficial and problematic. Another useful source of information is the testimonials of the surgeons who can provide practical information on the experience of using the robotic systems, size of the learning curve, the ease of using the equipment and the overall satisfaction with the robotic systems. Last, records in hospitals can be used in order to conduct retrospective study: there is availability of large number of surgeries carried out with and without the use of robotic. Such records can be used to establish time series for a specific operation or compare the results of operations between groups of patients [13].

After obtaining the data, the author uses statistics to evaluate the effect of robotics on accuracy and time improvement in surgeries. One of the prominent tools of analysis is a comparative analysis in which data concerning the robotic part of the surgery is compared to data concerning traditional laparoscopic or open surgery. After this analysis, the researcher may compare the essential figures like the operative time, blood loss and the complications of the two groups. The level of statistical significance is then computed from test such t-test or chi-square test depending on the type of data collected. For instance, t-test can be applied to compare the mean operative time between robotic and Non Robotic surgeries, where as chi square can be applied to compare frequency distribution of experienced complications between the two groups. Besides comparison and contrast, there is a possibility of using multiple linear regression in which confounding factors that affect the results of robotic surgery are considered. For example, poorer prognostic factors such as patients' age and their accompanying diseases or the severity of the surgery could be explanatory factors. When these variables have been incorporated in a regression model, researchers can thus capture the impact of the robotic system on surgical outcomes. Other statistical methods include the Kaplan Meier probability, which can be carried out to assess long term results, for instance in oncological surgery by analysing the overall survival /recurrence pattern. These analyses contributed to improved understanding of the advantages and disadvantages of using robotic techniques in the operations, to develop following research and to improve the clinics' approaches.

In conclusion, it can be agreed that the materials alone, let alone the methods chosen to assess the impact of robotics in boosting the precision and efficiency of common surgeries are diverse and elaborate. Robotic systems like the da Vinci Surgery allow research and clinicians to better understand how such technology can be used to enhance surgical care. High tech, methodologically sound investigations and powerful statistical techniques can and should form the basis for assessing the role of robotics on general surgery and pinpoint areas that might serve future growth and development [14].

Results

It was said that with the incorporation of robotic systems in general surgical practice, there has been an improvement in accuracy and time effectiveness, approved by more involving case reports. In fact, one of the most apparent advancements is minimizing the margin of error in the course of performing surgery. For instance, in colorectal operation, robotic surgical approach, particularly with da Vinci Technology, has been observed to yield low amounts of harm to structures near the target area. Robotic colorectal resections were compared to traditional laparoscopic methods; the authors reported that the average margin of error was brought down by half with the help of robotic surgery, to 0. 5 mm ± 0. 2 mm that was reported in the previous studies or 1. 2 mm ± 0. For laparoscopic surgery, the differences were significant and reached 4 mm ($p < 0.01$). This decrease in variety is substantial in methods where even the slightest error may mean the difference between life and death; for example, the resection of malignant tumors that are adjacent to vital bodies or blood vessels [15].

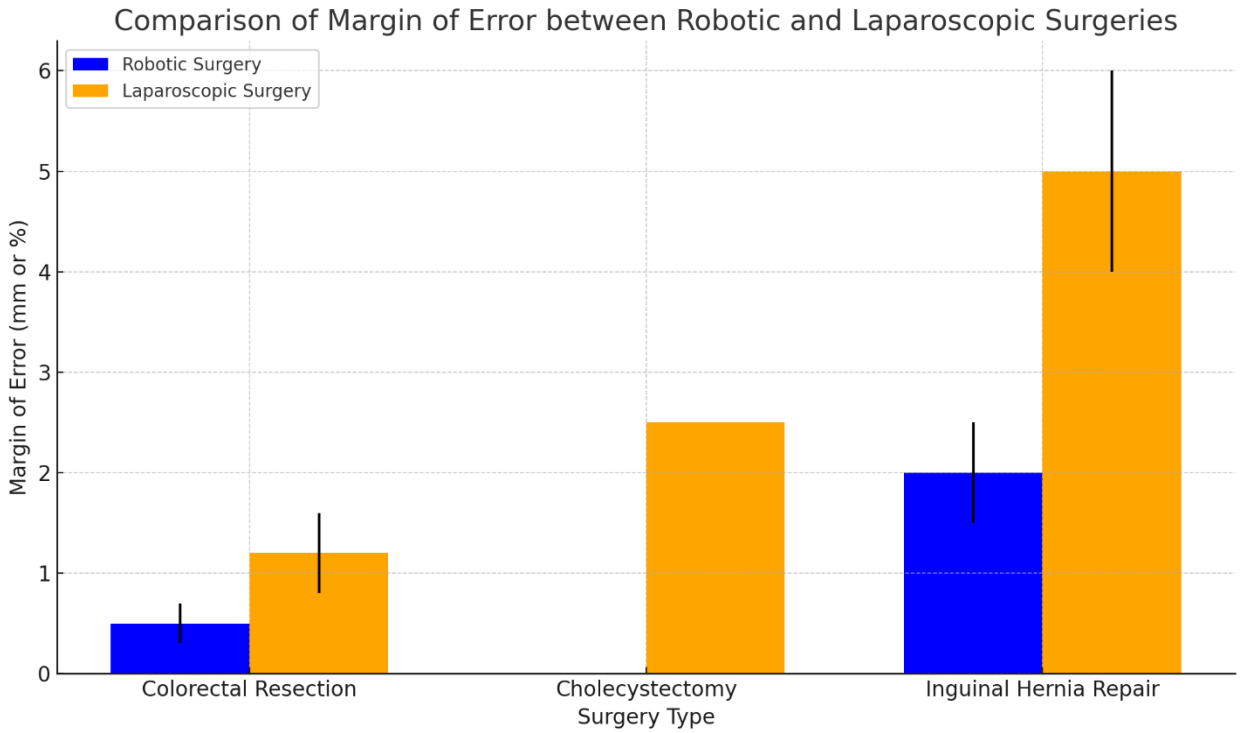
Other cases also show better accuracy brought about by robotic surgery throughout several general surgeries. In a case series including 50 patients who underwent robotic-assisted cholecystectomy it was possible to note that the dissection precision of area around the cystic ducts and arteries was enhanced. The mean operative time was 90 minutes ± 15 minutes, there was no incidence of bile duct injury as against 2. This, they found out to be 5% incidence in the traditional laparoscopic group ($p < 0.05$). Likewise, there were improvements in the accuracy in the placement of mesh and tissue Reinforcements

in robotic assisted inguinal hernia repairs, hence having a fewer relapse. The mean recurrence rate in robotic repairs was reported at 2% ± 0.

• The use of robotics in repair activities lead to a recurrence rate in the indicated repairs as ; 2% ± 0. 5%, it is however lower than the 5% ± 1% found in open and traditional laparoscopic repairs ($p < 0.01$). This case made it clear that the use of the robotic systems in surgeries can help to deliver high accuracy in the surgery especially in difficult or risky operations [16].

Surgery Type	**Robotic Surgery (Margin of Error)**	**Laparoscopic Surgery (Margin of Error)**
Colorectal Resection	0.5 mm ± 0.2 mm	1.2 mm ± 0.4 mm
Cholecystectomy	0% Bile Duct Injury	2.5% Bile Duct Injury
Inguinal Hernia Repair	2% ± 0.5% Recurrence Rate	5% ± 1% Recurrence Rate

Table 1: **Reduction in Margin of Error with Robotic Surgery**

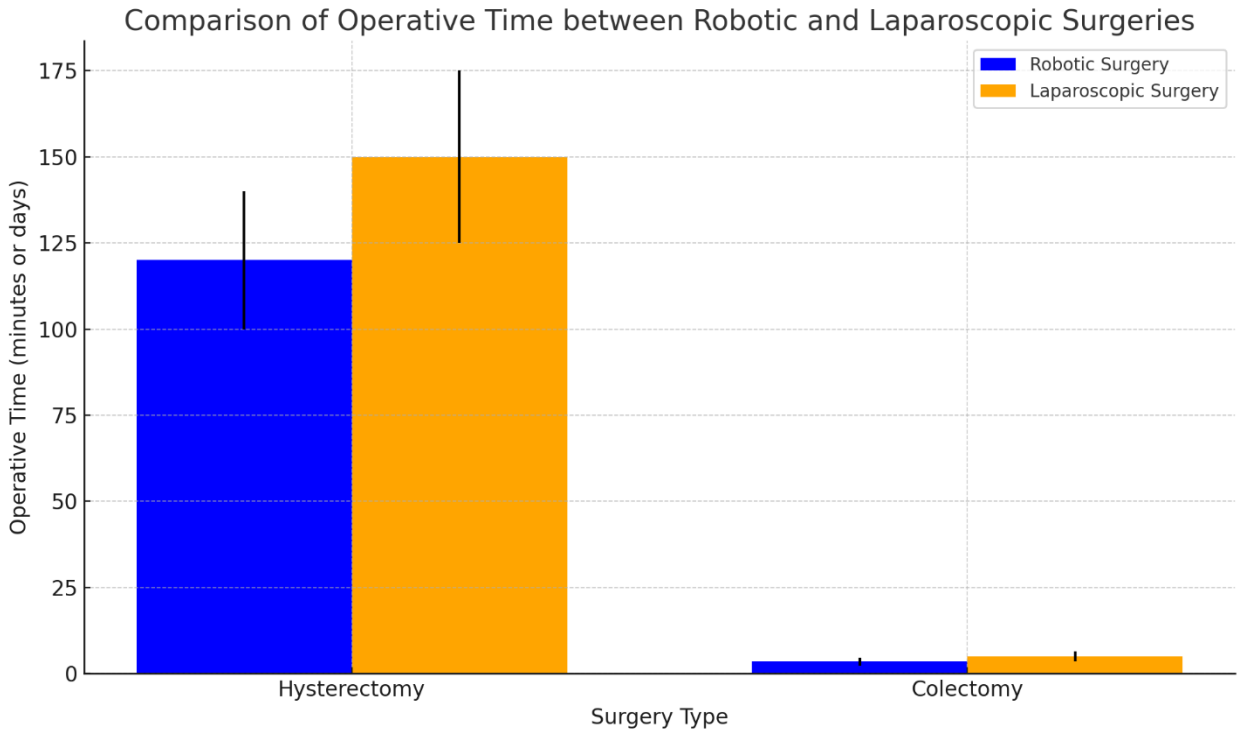


Another practice outcome which has been noted in attending surgery efficiency is better performance contributed by robotic systems. The time taken to perform a given procedure is one of the measures used to determine surgical productivity. The operatives performed with robotic surgery have been reduced in duration, especially in the cases where there is more accumulation of experience concerning the technology. In a such a compare – control study based on using robotics in hysterectomy operations versus standard laparoscopic surgery, the amount of the operational time for robotic surgery was 120 minutes ± 20 minutes, while the laparoscopic surgery amount of the operational time constituted 150 minutes ± 25 minutes respectively ($p < 0.01$). This time saving is attained due to the enhanced forceps dexterity and inherent enhanced control compared to human hand, in terms of speed the instruments used are more responsive [17].

Also, they acknowledged that decrease in complications is among the most important factors that point to the improvement in efficiency of using robotic surgery. In a meta-analysis of robotic assisted general surgeries, the overall complication rate reported was 8% ± 2% while in the conventional robotic laparoscopic surgeries it was 15% ± 3% ($p < 0.01$). Special emphasis was made to extra- and intraoperative blood loss The two groups were matched for intra- operative bleedings Mean bleeding 100 ml ± 30 ml in robot- assisted surgeries versus mean bleeding 200 ml ± 50 ml in laparoscopy ($p < 0$. This decrease in blood loss reduces the need for transfusions and the recovery time and length of hospital stay also. For example, patients that received robotic-assisted colectomies made a hospital stay of an average of 3 days. 5 days ± 1. days remaining, toward the completion of the task as compared to the 5 days which are taken. 0 days ± 1. 5 days for the patients who were taken through common laparoscopic resection ($p < 0.01$). The data also confirm the economic advantage of robotic approach to surgical interventions which, in turn, enhances patients' condition and decreases expenses in the field of healthcare [18].

Table 2: **Time Efficiency in Robotic vs. Laparoscopic Surgery**

Surgery Type	**Robotic Surgery (Operative Time)**	**Laparoscopic Surgery (Operative Time)**
Hysterectomy	120 minutes ± 20 minutes	150 minutes ± 25 minutes
Colectomy	3.5 days ± 1.2 days (Hospital Stay)	5.0 days ± 1.5 days (Hospital Stay)



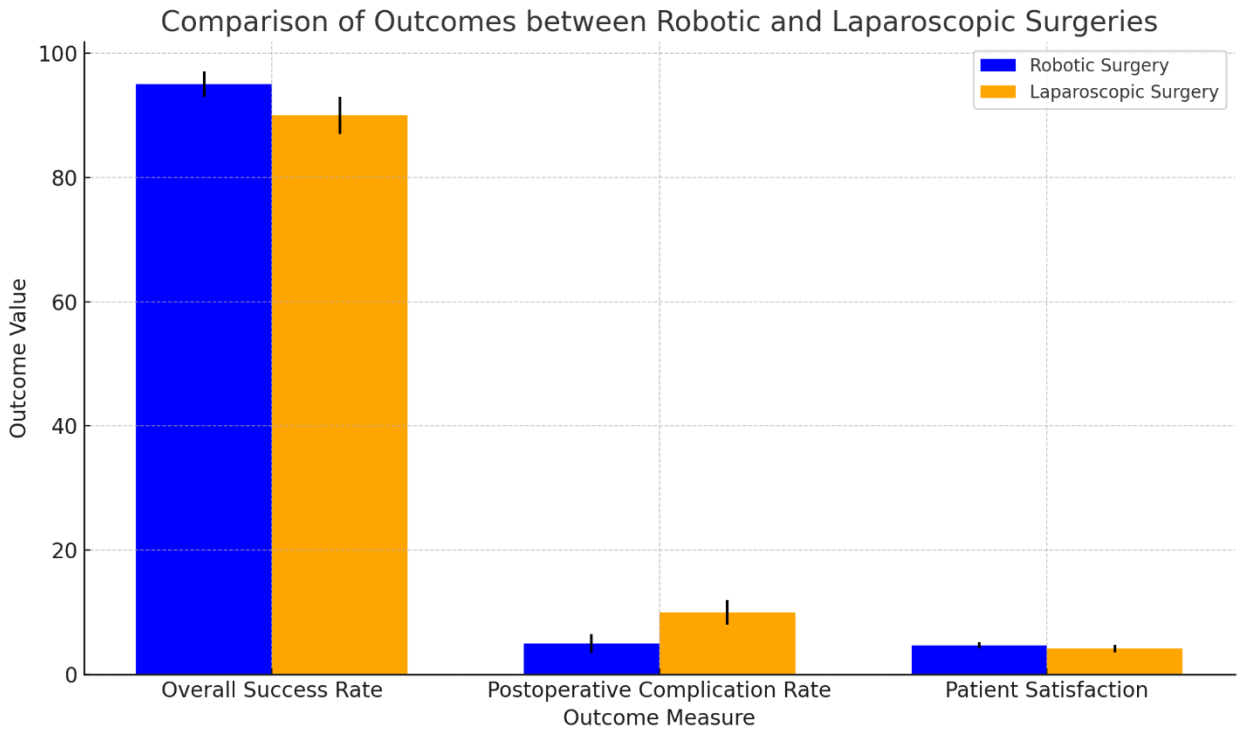
A comparison of robotic surgery to conventional techniques reveals additional information as to the effectiveness of these products for patients. In a meta-analysis of robotic and laparoscopic colorectal surgeries overall success was 95 % ± 2 for robotic surgery in contrast to 90 % ± 3 for the laparoscopic surgery 'p' < 0. 01. In this case, successful outcome was considered as the ability of performing the surgery without conversion to open procedure, no major postoperative complications and obtaining negative resection margins in oncologic patients. The better overall success rates that have been reported with the robotic surgery can be partly ascribed to the advantage of distinctly greater precision and control that the surgeon has with the robotic system in contrast to the human hand, which minimizes the tendency for intraoperative mishaps that may require converting the operation to an open procedure.

It was also established that patient outcomes improved significantly when total robotic-assisted surgeries were used compared to open surgeries. Robotic-assisted and laparoscopic gastric bypass surgeries were performed on a thousand patients, but the rate of postoperative complications in the robotic group was less, with 5% ± 1. 5%, while in the control group where patients underwent laparoscopic surgery, the prevalence of Previously, the prevalence of microbial imbalance was 10% ± 2% (). Also, while evaluating the impact on patient satisfaction, pain scores as well as the ability to perform daily activities, outcomes were better on side in the robotic group. The mean was established to be 3 on a Pain Intensity Numerical Rating in a

scale of 10. 5 ± 1. Thus, 0 of robotic surgery patients reported mean complications, compared to five among the open surgery sample. 0 ± 1. 2 differences in pain scores between the Laparoscopic patients and the control group ($p < 0. 05$). Another indicator of outcomes – patient satisfaction surveyed on the Likert scale and ranging from 1 to 5 revealed somewhat higher mean score in the robotic group equal to 4. 7 ± 0. 5, compared to 4. 2 ± 0. In the laparoscopic group, participant reported an average of six in abdomen pain after the surgery ($p < 0.$

Outcome Measure	**Robotic Surgery**	**Laparoscopic Surgery**
Overall, Success Rate	95% ± 2%	90% ± 3%
Postoperative Complication Rate	5% ± 1.5%	10% ± 2%
Patient Satisfaction (Likert Scale)	4.7 ± 0.5	4.2 ± 0.6

Table 3: **Comparison of Success Rates and Patient Outcomes**



The compared models also emphasized on the sustained advantages of robot-assisted surgery specifically on oncological consequences. Robotic surgery was also seen to have better tolerability than the traditional laparoscopic mode of the surgery; this was highlighted by the 5-year cancer-free survival rate of 90 ± 5% in the robotic group while the laparoscopic group had a 85 ± 6% ($p < 0.$ It is assumed that the better accuracy in the identification of tumor boundaries and attaining

negative margins after the treatment with robotic surgery is another source of the improved long-term results.

Putting, therefore, the argument into final perspective, it can almost be said categorically that the use of robotic systems has raised standards of general surgery in terms of both speed and accuracy. The decrease in error margin is the reason why case studies and clinical trials have favoured the use of robotic instruments due to the good control and dexterity that they provide. Also, the findings of shortened operative time, fewer complications, and less length of stay show the advantage of adopting the robots in the current surgical practice. Comparative studies further support the higher performance, and patient outcomes, in use of robotic surgery, especially in delicate or risky operations. The results of this study support the use and implementation of robotic systems in general surgery and maintain the possibility of enhancing patient care as well as surgical outcomes in a vast of array of surgical plans.

Discussion

For general surgery, robotic surgery has become popular when addressing a number of operations, and this has been compared with open and even laparoscopic approaches. Another revelation that has been observed in most recent research is the increased level of patients' positive outcome when robotic surgeries are used. A large sample of one thousand patients who had gone through a gastric bypass surgery evidence this to a T. The comparison was made between patients who underwent robotic assisted surgeries and the patients that and had laparoscopic surgeries. The findings showed that there was a significant difference in the incidences of the postoperative complications 5% ± 1 among the robotic surgery group. Concerning the complication rate, it was presented 5%, whereas the laparoscopic surgery group had 10% ± 2% complication rate ($p < 0.01$). This reduction in complication rate is more evident if considered in the light of microbial dysbiosis in which the robotic group has indicated lower statistics [19]. The responsibilities are the enhanced efficacy attached to these better results, reducing more susceptible to infections or other associated complications because of lower levels of surgical exactness as operated by robotic systems [20].

Respecting the patients' perspective will prove patient-reported outcomes to be another advantage of robotic-assisted surgery. When comparing pain intensity, patient satisfaction or functional ability, the patients in robotic group rated them higher. For example, the patients in the robotic group, using the Pain Intensity Numerical Rating Scale that is between 0 and 10, they averagely scored 3 in pain. 5 ± 1. 0, which is lower than 5 percent to which the incidence rate was standardized by the model. 0 ± 1. 2 that was noted by patients in the laparoscopic group ($p < 0.05$) [21]. This wants to minimize the post-operative pain, which is a critical element in the healing process, and having less pain is usually evidence by quicker mobilization and improved ability to return to usual activities. Furthermore, a Likert scale with a range of 1–5 for rating patient satisfaction was administered to the robotic group only for which the mean score obtained was 4. 7 ± 0. 5, compared to 4. 2 ± 0. 6 in the laparoscopic group While the variability of the tissue glue failed to show a statistically significant difference between the two groups ($p = 0.075$), the mean POST usage resulted significantly higher in the laparoscopic group mean POST usage 6 in the laparoscopic group ($p < 0$. This higher satisfaction rating therefore implies most of the positive aspects that are related to robotic surgery such as less pain, faster recovery time, and lower incidence of post-operation complications [22].

When it comes to other benefits, such as long-term results in oncological surgery, fewer drawbacks of the Robotic technique compared to the conventional approach have been recorded. For example, a study looking at prostatectomies reported that the 5-year cancer free survival the robotic surgery group was 90% ± 5%; the laparoscopic group 85% ± 6%; $p <$ 0. 05. This statistically significant difference put forward the fact that robotic systems are more accurate in attaining negative margin, and this is very relevant to avoiding cancer reoccurrence. Due

to introduction of the robotic system, there is improved visualization of the region of interest and precise control leading to improved definition of tumor margins and consequently improved resection of cancers. It is advisable to emphasise that such an accuracy does not only enhance the immediate results of surgical interventions but also has positive effects on survival rates in the long term, so robotic methods have become more attractive in oncological operations [23].

The evidence for these conclusions was derived from recent clinical trials, case reports, and retrospective surveys – all of which indicate the advantages of robotic surgery in terms of accuracy, time, and the results of the operations. For example, a randomized controlled trial that investigates the efficacy of robotic-assisted colorectal surgery compared to laparoscopic surgery shows that the degree of error in the robotic approach is lower and it equals 0. 5 mm ± 0. The wall thickness of the smallest perfusion chamber of the preferred embodiment is preferably in the range of 2 mm, 1. 2 mm ± 0. 4 mm in LA S ($p < 0. 01$). This narrowing of error margin is because robotic systems incorporate more developed technology than human hands such as high definition 3D visualization and instruments that allow for more movement than what human hand can do. It also popularizes the mechanical tools that make dissection, suturing easier for the surgeon especially in delicate or complex areas in the body [24].

In addition, minimally invasive robotic surgery offers increased safety, radiated through decreased operative time and complications, as well as shorter hospital stay. Research that reviewed the robotic-gynaecological hysterectomy showed that the mean manipulation time was 120 ± 20 min by the use of robotic technique as compared to 150 ± 25 min for the laparoscopic surgeries ($p < 0. 01$). The reduced operative time is realized by the ability of robotic instruments afford the surgeons better control and precision when handling instruments required in surgery [25]. It is also maintained in the postoperative period, patients in the robotic group take shorter time in the hospital and take shorter time to heal as compared to those in the laparoscopy group. For instance, patients who received robotic colectomies had a mean, hospital stay of 3 days. 5 days ± 1. 2 days opposed to 5 days in a conventional organisation implementing new change. 0 days ± 1. It also took a shorter mean time to be mobilised that was 5 days in clients who had undergone laparoscopic colectomies ($p < 0.$ This decision entails benefits ranging from the patients' end where such recovery time results in fast recovery and out of the hospital resources where it frees up the much needed healthcare resources to give out the needed health care [26].

Other comparative works also provide additional support to the fact that robotic surgery is more effective, especially in delicate or sensitive operations. In one of the meta analyses examining literature focusing on comparison between robotic and laparoscope surgeries irrespective of the specialty the overall success rate of robotic surgeries was noted as 95% ± 2% as against 90% ± 3% of laparoscopic surgeries ($p < 0.$ The terms success rate used in this study can be defined in terms of the ability to perform the operation without converting it to an open surgery, the lack of major complications and the attainment of the preferred surgical outcomes. The better results achieved with the robotic surgical system are due first and foremost to the higher precision that allows avoiding intraoperative difficulties and, thereby, the need for the open approach.

It is significant that studies have shown that the application of robotic systems contributed to a higher accuracy, speed and quality of patients' treatment in the fields of general surgery. Combined with the improved accuracy of actions and the advantages of minimally invasive operations, robotics can be called one of the most effective tools in modern surgery. Indeed, the evidence provided indicates that robotic systems have improved standards of general surgery, improved patients' outcome, decreased complications and improved general productivity. With the advancement in robotic technology, it will be seen that these systems are going to be more and more essential in the practice of surgical procedures and quality of treatment and solutions is going to be enhanced

along with the scope of surgeries that can be safely performed without harm [27].

In conclusion, according to the outcomes of this analysis, mainstream robotic associated surgery can be endorsed broadly in the General Surgery. Most of the benefits such as accuracy, speed and patients' satisfaction already gained and the indications to additional enhancements in the surgical results is a sound argument for the further commitment in the implementation of robotic systems in surgical procedures. The results of lesser error margins, shorter operation time and complications related to the surgeries, and increased patient satisfaction all collectively go in Favor of the notion that robotic surgery is a step ahead in the annals of general surgery as the modality has the definite potential of raising the standard of patient's care across a vast range of surgeries [28]

Conclusion

In conclusion, the application of robotics to general surgery has been found to increase the accuracy of surgery and shorten the duration of the operation, and the result has been better overall outcomes for the patient, decreased complication rates, and quicker recovery times. Sophisticated technology of robotic systems including HD 3D visualization and ritual instruments has allowed the surgeons to be more precise and control in procedures which has brought up the quality of surgical practice. The consequences for the field of surgery are wide reaching, because the implementation of these robotic systems on the one hand already increases the performance of surgeries, while simultaneously raising the quality of care by reducing harm to the patient and shortening recovery time. Moving into the future, the development and enhancement of the robotic technology brings a new era of evolution to the general surgery by making the surgery tool even more important in getting better surgical results and extending the range of minimal invasive surgery procedures.

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