Ain Shams Journal of Forensic Medicine and Clinical Toxicology
January 2024, 42: 53-67

Robotic Surgery on the Verge of Medical Ethics and Liability: Cross-Sectional Study in Ain Shams University Hospitals

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Abstract

Background: Robotic surgery is one of the newest techniques applied in surgery hoping to minimize pain and time spent in recovery. It can perform complicated surgical techniques through small incisions. Multiple robotic surgical systems are currently in use. The growing implementation of robotic surgeries is mandating the understanding of their application's ethical and legal aspects. **Aim of the Work:** This study is aimed at evaluating the ethical and medico-legal commitment of the medical staff in robotic surgery in Ain Shams University (ASU) Hospitals. **Participants and Methods:** A Self-administered structured questionnaire was created and filled by the general surgeons, urology surgeons, obstetricians, and gynecologists working in Ain Shams University (ASU) Hospitals, during the period from June 2022 to December 2022. **Results:** 78% of participants had satisfying knowledge with a total score ranging from 3 to 5 with a Median (IQR) of 4 (4-5): 80% of participants had excellent practice and attitude while 20% had good practice and attitude regarding the ethics of robotic surgery. 16% of participants had excellent awareness of medico-legality while 78% of the participants had a good awareness. There was a positive correlation was found between the practice and attitude total score and the awareness of medico-legality total score. There was a highly significant relation between the awareness of medico-legality total score and the surgeon's involvement in the robotic operation. The medical error total score ranged from 0 to 4 with a Median (IQR) of 1 (1 – 2). **Conclusion:** Most surgeons working at ASU hospitals have satisfying knowledge, accepted practice, and attitude, good awareness of medico-legal issues, and medical errors regarding the ethics of robotic surgery, and would prefer robotic surgery over conventional surgery in the future.

Received in original form: 7 September 2023
Accepted in a final form: 2 January 2024

Key words Robotic surgery, Ethics, Medico-legal issues, Innovation challenges, Ain Shams University Hospitals

Introduction

Robotic surgery is one of the most talked-about subjects in surgery that carries significant promise for minimizing pain and time spent in recovery. It can perform complicated surgical techniques through very small incisions, leaving a very little scar. Multiple robotic surgical systems are currently in use, but the most popular is the da Vinci® Surgical System. With increasingly sophisticated da Vinci® models, thousands of units have been sold worldwide (Sharkey & Sharkey, 2013).

Robotic surgery is new for use in EGYPT where the pioneer is Ain Shams University (ASU) Hospitals. The surgeon using robotic technology is able to operate with great accuracy beyond the accuracy of the human hand, and under the three-dimensional vision that was not previously available in very narrow places in the human body which resulted in great progress in the surgical results compared to conventional techniques. So, Prof. Dr. Mahmoud El-Metini, President of Ain Shams University, explained that the university was keen to introduce robotic surgery technology in its university hospitals (https://www.asu.edu.eg/ 3048/ news/the-success-of-the-first-robotic-cholecystectomy-in-egypt-at-ain-shams-specialized-hospital)

The growing applications of robotic surgical systems are mandating an understanding of the ethical and legal aspects of their use. There are multiple ethical considerations including respect for autonomy, beneficence, non-maleficence, and justice (Wightman et al., 2020).

When a patient undergoes robotic surgery, there are many stakeholders at risk for medico-legal compliance including the device manufacturer, the surgical team, and the hospitals (Hechenbleikner &Jacob, 2019).

If the technology is to succeed in the long term, it must be ensured that patients are getting fair and reasonable treatment that respects their human rights and dignity. Doctors should not let the promise of a revolutionary new technology blind them to the difficulties and ethical issues involved in the early stages (Sharkey & Sharkey, 2013).

Aim of the Work

This study aimed to evaluate the ethical and medico-legal commitment of the medical staff in robotic surgery in Ain Shams University (ASU) Hospitals.

Participants and Methods

Design:

This descriptive cross-sectional exploratory study was conducted on general surgeons, urology surgeons, obstetricians, and gynecologists working at Ain Shams University (ASU) Hospitals from June 2022 to December 2022 based on the data collected from the selected participants for the study.

Inclusion and Exclusion Criteria:

General surgeons, urology surgeons, obstetricians, and gynecologists working in departments practicing robotic surgery, who understood the aim of this study after it was explained to them, and accepted to fulfill the proposed questionnaire, with the exclusion of other departments not practicing robotic surgery.

Sampling Method:

A self-administered questionnaire was handed out through an interview with the participant with both anonymity and confidentiality secured during the stage of data collection.

Sampling:

The number of the studied participants was calculated using the PASS 11 program, assuming that the frequency of ethical challenges facing healthcare professionals = 50% ± 10%, and at a 95% confidence level, a sample size of 50 robotic surgeons could detect this frequency and ensured the collection of reliable data, correct results, statistics, and conclusions.

One stage cluster sampling design was used in this study to select a representative sample of robotic surgeons working in Ain Shams University Hospitals.

Ethical considerations: The aim of the research was explained to the participants followed by obtaining oral consent before fulfilling the questionnaire. Participation in the study was voluntary without providing any rewards and carried no risk for participants. Participants were informed about their right to withdraw at any time without any consequences. The questionnaires were anonymous, and all identifying data would not be mentioned. This study got the approval of the ethical committee of the Faculty of Medicine, Ain Shams University, code number (MS 473/2022).

Tool for data collection:

A self-designed questionnaire was created to collect the necessary data for evaluating the ethical and medico-legal commitment in robotic surgery in Ain Shams University Hospitals.

Questionnaire structure:

The questionnaire was divided into four sections gathering the related questions with each other. The first section assessed the socio-demographic characteristics of the participants and the second section was concerned with participants' ethical awareness regarding robotic surgery. The third section was concerned with assessing how the robotic surgeon deals with ethical concepts during the management of cases of robotic surgery. The last section was concerned with assessing how the robotic surgeon deals with medico-legal problems arising from the application of robotic surgery in different fields.

Procedure of the study:

The questionnaire was prepared by the researchers using English language. Then, it was revised by a group of experts in the Forensic Medicine and Toxicology Department, Faculty of Medicine, Ain Shams University. Based on the opinion of a panel of experts, vague and confusing questions were excluded; some modifications were done; and then the final form was developed.

The questionnaire format was filled in by the participants and some clarifications in Arabic for difficult ethical terms were presented by the researcher through an interview with the participant.

The designed questions were closed-ended and arranged in a logical order; starting with easy, closed-ended questions that encouraged the participant to continue. If the answer to a question depended on the answer to the previous one, it was placed directly next to it.

Statistical analysis:

The collected data were revised, coded, and entered into a PC using Statistical Package for Social Science (IBM SPSS for Windows) version 23. Data were analyzed according to the type of data obtained for each parameter. Descriptive statistics were presented as frequency with percentages for categorical variables. The level of significance is considered when the P value is ≤ 0.05. Spearman correlation coefficients were used to assess the correlation between two quantitative parameters in the same group.

Results

Fifty questionnaires were distributed to general surgeons, Urology surgeons, obstetricians, and gynecologists working in ASU Hospitals (El-Demerdash, Obs & Gynae and Ain Shams Specialized University Hospitals): The response rate was 100%.

As shown in Table (1), the age of the participants was as follows: (62%) were < 30 years, (28%) from (30 _ 40) years, (6%) from (>40 _ 50) years, and only (4%) were > 50 years. As regard gender: males were greatly more than females (82%) and (18%) respectively. Regarding the occupation, the majority of the study participants were assistant lecturers (50%), followed by residents (30%), with equal distribution between professors and assistant professors (8% for each), and 4% for lecturers. Looking at their specialties, general surgery took the largest percentage 62%, followed by Obstetrics & Gynecology 20% with the smallest percentage being 18% for urology surgeons. Regarding the participants' duration of work experience, 74% of them had less than 5 years of experience, 8% had a duration of experience from 5 up to 10 years, another 8% had a duration of experience from >10 up to 15 years and 10% had an experience of more than 15 years. Regarding the involvement in robotic operations, 16% of participants had performed one or more operations, 30% assisted the surgeon during the operation, 50% just were present for remote viewing and follow-up, and 4% just got trained to use the robot.

Table (2) showed that (98%) of the participants were aware of the patient's rights to refuse a robotic surgery and respected the patient's autonomy, 40%

believed that all patients have the capacity to make informed consent, 58% didn't have this belief, and only 2% weren't sure about their response. All participants knew that informed consent must be taken voluntarily and without undue influence, 90% of them believed that robotic surgery provides better access to the surgical field than conventional techniques while 8% didn't. 34% of participants believed that robotic surgery shouldn't carry any minimal harm to the patient for being applied while 60% denied this.

Regarding the practice and attitude of the 50 participated surgeons working at ASU hospitals towards the ethics of robotic surgery; Table (3a) showed that the fear of harming the patient prevents 30% of participants from training in robotic surgery while this fear does not affect more than half of the participants (64%): 80% of participants would prefer robotic surgery over conventional surgery if the patient's condition was equal for both while 16% would prefer conventional surgery. 82% of participants select patients for robotic operation based on their health condition to ensure the highest rate of recovery with the exclusion of critical patients and delayed cases while 78% of participants select patients for taking advantage of their condition in development and scientific research, 40% of participants consider patients' financial ability without regard to their health condition and patient waiting lists, and 48% of participants select patients by personal preference of the doctor.

Table (3b) showed that all participants (100%) took written informed consent from the patients before undergoing robotic surgeries. Most of the participants (88%) endorsed the importance of providing patients with information about the surgeon's experience in robotic surgery; 44% for complete agreement and just agreed, and only 2% completely disagreed. 100% of participants favored explaining the impact of using the surgical robot on the operation time compared to conventional methods for patients with 60% of the entire complete agreement and 40% just agreeing. Also, nearly all the participants (96%) favored explaining all robotic surgical details and complications for patients even if they are so bad; 68% completely agreed and 28% just agreed. 82% of participants affirmed informing the patient about the success rate of relevant robotic surgeries carried out in EGYPT and only 18% didn't favor any opinion about this.

Table (3c) showed the responses of 50 surgeons working at ASU hospitals who participated in this study regarding preserving patients' confidentiality. It showed that 50% of participants advocated the possibility of disclosing patient's private information within earshot of others who are not involved in the patient's care at the work unit while 30% of participants refused such disclosure. 20% of participants didn't stand up for any answer about this issue. 50% of the participants confirmed informing the patient if using a robotic device is merely a personal preference of the doctor but 26% refused to express their preference to the patient while 24% didn't sustain any opinion on this issue. Only 4% of participants validated using robotic devices in operations for research and development without the patient's permission for the purpose of benefiting other patients, while 94% of participants denied doing this. Additionally, most of the participants (86%) affirmed the possibility of photographing robotic operations for marketing through social media as long as the patient agrees with 42% of complete agreement and only 8% of participants disagreed with this. Regarding overestimating expectations of results of robotic operations for encouraging the patient to undergo this operation, 88% of participants denied this overestimation while only 6% of participants stood up for it. Only 10% of participants endorsed that robotic surgery would decrease the rate of liability of doctors while 74% of them objected. On the other hand, 16% of participants didn't have any opinion about this issue. All participants (100%) supported the importance of a surgeon's training in conventional surgical techniques besides robotic techniques for the benefit of the patient, with 92% in complete agreement.

Table (4) showed that almost all (98%) of participants considered that the patient's consent before robotic surgery is protection for the surgeon. However, only 22% of participants supported the patient's right to sue the surgeon if the patient is harmed due to advice about robotic surgery published on social media, while 64% of participants objected to this right. 14% of participants didn't side with any opinion. 34% of participants advocated the patient's right to sue the surgeon if the patient was harmed by publishing his robotic surgery on social media even if he made informed consent. On the other hand, 60% of participants were unconvinced about this right with 32% complete disagreement. 88% of participants endorsed that the occurrence of medical error during robotic surgery is possible and doesn't mean negligence from surgeons in all cases. 4% of participants completely disagreed and 8% didn't have any opinion. On the other hand, only 34% of the participants confirmed that the surgeon is responsible for any postoperative patient complications after robotic surgery, even if he adheres to the guidelines for diagnosing and performing the surgery, while 54% of participants refused this responsibility. 12% didn't stick up for an opinion. 54% of participants were convinced that the patient has no right to sue the surgeon when robotic complications occur, as long as the doctor has obtained the patient's informed consent by explaining all possible complications. On the other hand, 32% of participants advocated this right for the patient. 14% were neutral for all answers. 94% of participants confirmed that it is in the surgeon's interest to have a hospital system for reporting a robotic surgical error as soon as the error occurs. Only 2% of participants disagreed and 4% had neutral responses. Furthermore, more than half of the participants (54%) negated that it is difficult for the surgeon to report to the hospital upon making a

mistake regarding robotic surgery. 32% of participants confirmed this difficulty while 14% didn't sustain any opinion. Most of the participants (84%) endorsed that the hospital performing robotic surgeries is responsible for its staff performance and is considered liable if there is proven negligence from them. Only 10% of participants objected to this responsibility. 42% of participants affirmed the accountability of surgeons for the robotic errors made by the surgical team and device technicians. On the other hand, 20% of participants denied this accountability and 38% had neutral opinions.

Table (5) showed that 46% of participants in this study performed or assisted the surgeon during robotic operations and 100% of them denied being about to perform robotic surgery on the wrong body part or on the wrong patient. Regarding participants who performed or assisted the surgeons; (17.4%) of them were about to miss a foreign object inside the patient (e.g., tool, or gauze), (43.5%) caused organ, vascular, or nerve damage, and 13% experienced infection or contamination during robotic surgeries. only (8.7%) of participants gave inadequate instructions to the patient which resulted in complications, (56.5%) of participants experienced a mistake due to improper functioning robotic devices /equipment during robotic surgeries and (4.3%) experienced failure of communication between staff. The medical error total score ranged from 0 to 4 with a Median (IQR) of 1 (1 – 2):

Table (6) showed damage resulting from a medical error during robotic surgeries exploring that none of the participants experienced either patient death or loss of an organ or its function. Additionally, only 18% of the studied surgeons experienced prolonged hospital stays and only 2% of them experienced repeated post-operative complaints with their patients after robotic operations. 24% of participants needed to perform another surgical intervention by turning the robotic technique to the conventional method.

Table (7) showed that upon the occurrence of a medical error that has been remedied during robotic surgeries, only 30% of participants would keep the matter secret and tries to hide it from everyone while 66% would refer the matter to the hospital administration and 50% would tell the patient what happened. There is an overlap between the percentage of participants who wouldn't keep the matter secret as some of them would tell the patient without telling the hospital and vice versa. None of the participants would avoid performing robotic surgery in the future at all after the occurrence of a medical error while 30% of them would avoid performing robotic surgery in patients with the same condition. Furthermore, none of the participants (0%) has been accused of making a medical error during robotic surgery.

Table (8) showed that the total score of knowledge regarding the ethics of robotic surgery ranged from 3 to 5 with a Median (IQR) of 4 (4-5): 78% of participants had satisfying knowledge while 22% had unsatisfying knowledge. The total score of practice and attitude of participants in this study regarding the ethics of robotic surgery ranged from 31 to 52 with a Median (IQR) of 40.5 (39 - 45): 80% of participants had excellent practice and attitude while 20% had good practice and attitude regarding the ethics of robotic surgery. The total score of the awareness of medico-legality of participants in this study regarding the medico-legal issues of robotic surgery ranged from 23 to 50 with a Median (IQR) of 39 (34 - 42): 16% of participants had excellent awareness of medico-legality while 78% had a good awareness of medico-legality and 6% had poor awareness of medico-legality regarding the medico-legal issues of robotic surgery.

Table (9) showed that there was a positive correlation found between the practice & attitude total score and the awareness of medico-legality total score.

Table (1): Frequency distribution of socio-demographic criteria of the participated 50 surgeons working at ASU hospitals.

Socio-demographic criteria		No.	%
Age (yrs.)	< 30	31	62.0%
	30-40	14	28.0%
	>40-50	3	6.0%
	> 50	2	4.0%
Gender	Man	41	82.0%
	Woman	9	18.0%
Occupation	Resident	15	30.0%
	Assistant lecturer	25	50.0%
	Lecturer	2	4.0%
	Assistant Professor	4	8.0%
	Professor	4	8.0%
Specialty	General surgery	31	62.0%
	Urology surgery	9	18.0%
	Obstetrics & Gynecology	10	20.0%
Working experience (yrs.)	< 5	37	74.0%
	5-10	4	8.0%
	>10-15	4	8.0%
	>15	5	10.0%
Involvement in robotic operation	You have performed one or more operation	8	16.0%
	Assisting the surgeon during the operation	15	30.0%
	Just being present during the operation for remote viewing and follow-up	25	50.0%
	Just get trained to use the robot	2	4.0%

Table (2): Frequency distribution of knowledge of the 50 participated surgeons working at ASU hospitals regarding the ethics of robotic surgery.

Knowledge in relation to the ethics of robotic surgery		No. (%)
Awareness of the patient's right to refuse to undergo a robotic surgery with or without reason.	No	1 (2.0%)
	Yes	49 (98.0%)
	Not sure	0 (0.0%)
The belief that all patients have the capacity to make an informed consent	No	29 (58.0%)
	Yes	20 (40.0%)
	Not sure	1 (2.0%)
The informed consent must be taken voluntarily and without undue influence	No	0 (0.0%)
	Yes	50 (100.0%)
	Not sure	0 (0.0%)
The belief that robotic surgery provides better access to the surgical field than conventional techniques	No	4 (8.0%)
	Yes	45 (90.0%)
	Not sure	1 (2.0%)
The belief that robotic surgery shouldn't carry any minimal harm to the patient for being applied	No	30 (60.0%)
	Yes	17 (34.0%)
	Not sure	3 (6.0%)

Table (3a): Frequency distribution of practice and attitude of the 50 participated surgeons working at ASU hospitals regarding the ethics of robotic surgery.

Practice & attitude of participants regarding the ethics of robotic surgery:		No.	%
The fear of harming the patient prevents training on robotic surgery.	No	32	64.0%
	Yes	15	30.0%
	Not sure	3	6.0%
Preference of robotic surgery over conventional surgery if the patient's condition is equal for both.	No	8	16.0%
	Yes	40	80.0%
	Not sure	2	4.0%
Selection of patients for robotic operation based on:			
a. Their health condition to ensure the highest rate of recovery with the exclusion of critical patients and delayed cases	No	8	16.0%
	Yes	41	82.0%
	Not sure	1	2.0%
b. Taking advantage of their condition in development and scientific research	No	10	20.0%
	Yes	39	78.0%
	Not sure	1	2.0%
c. Only their financial ability without regard to their health condition and patient waiting lists	No	27	54.0%
	Yes	20	40.0%
	Not sure	3	6.0%
d. Personal preference of the doctor	No	22	44.0%
	Yes	24	48.0%
	Not sure	4	8.0%

Table (3b): Frequency distribution of practice and attitude of the 50 participated surgeons working at ASU hospitals regarding the ethics of robotic surgery.

Practice and attitude regarding the ethics of robotic surgery:		No.	%
Taking patient's consent before robotic surgery by:	implied consent	0	0.0%
	blanket consent	0	0.0%
	oral consent	0	0.0%
	written informed consent	50	100.0%
Providing information about the surgeon's experience in robotic surgery for patients.	Neutral	2	4.0%
	Complete disagreeing	1	2.0%
	Disagree	3	6.0%
	Agree	22	44.0%
	Completely agree	22	44.0%
Explaining the impact of using the surgical robot on the operation time compared to conventional methods for patients	Neutral	0	0.0%
	Complete disagreeing	0	0.0%
	Disagree	0	0.0%
	Agree	20	40.0%
	Completely agree	30	60.0%
Explaining all robotic surgical details and complications for patients even if they are so bad	Neutral	2	4.0%
	Complete disagreeing	0	0.0%
	Disagree	0	0.0%
	Agree	14	28.0%
	Completely agree	34	68.0%
Informing the patient about the success rate of relevant robotic surgeries carried out in EGYPT	Neutral	9	18.0%
	Complete disagreeing	0	0.0%
	Disagree	0	0.0%
	Agree	22	44.0%
	Completely agree	19	38.0%

Table (3c): Frequency distribution of practice and attitude of the 50 participated surgeons working at ASU hospitals regarding the ethics of robotic surgery.

Practice and attitude regarding the ethics of robotic surgery:		No.	(%)
Disclosing patient's private information within earshot of others who are not involved in the patient's care at the work unit	Neutral	10	(20.0%)
	Complete disagreeing	5	(10.0%)
	Disagree	10	(20.0%)
	Agree	22	(44.0%)
	Completely agree	3	(6.0%)
Informing the patient if using a robotic device is merely a personal preference of the doctor	Neutral	12	(24.0%)
	Complete disagreeing	1	(2.0%)
	Disagree	12	(24.0%)
	Agree	16	(32.0%)
	Completely agree	9	(18.0%)
Using robotic devices in operations for research and development without the patient's permission for the purpose of benefiting other patients	Neutral	1	(2.0%)
	Complete disagreeing	26	(52.0%)
	Disagree	21	(42.0%)
	Agree	1	(2.0%)
	Completely agree	1	(2.0%)
Photographing robotic operations for marketing through social media as long as the patient agrees	Neutral	3	(6.0%)
	Complete disagreeing	2	(4.0%)
	Disagree	2	(4.0%)
	Agree	22	(44.0%)
	Completely agree	21	(42.0%)
Overestimating expectations of results of robotic operations for encouraging the patient	Neutral	3	(6.0%)
	Complete disagreeing	20	(40.0%)
	Disagree	24	(48.0%)
	Agree	3	(6.0%)
	Completely agree	0	(0.0%)
Robotic surgery will decrease the rate of liability of doctors	Neutral	8	(16.0%)
	Complete disagreeing	11	(22.0%)
	Disagree	26	(52.0%)
	Agree	3	(6.0%)
	Completely agree	2	(4.0%)
Surgeon's training in conventional surgical techniques besides robotic techniques	Neutral	0	(0.0%)
	Complete disagreeing	0	(0.0%)
	Disagree	0	(0.0%)
	Agree	4	(8.0%)
	Completely agree	46	(92.0%)

Table (4): Frequency distribution of awareness of the 50 participated surgeons working at ASU hospitals regarding medico-legal issues of robotic surgery.

Awareness regarding medico-legal issues of robotic surgery:		No.	%
Patient's consent before robotic surgery is a protection for the surgeon	Neutral	0	0.0%
	Complete disagreeing	0	0.0%
	Disagree	1	2.0%
	Agree	7	14.0%
	Completely agree	42	84.0%
The right to sue the surgeon if the patient is harmed due to advice about robotic surgery published on social media	Neutral	7	14.0%
	Complete disagreeing	14	28.0%
	Disagree	18	36.0%
	Agree	4	8.0%
	Completely agree	7	14.0%
The right to sue the surgeon if the patient was harmed by publishing his robotic surgery on social media even if he made informed consent	Neutral	3	6.0%
	Complete disagreeing	16	32.0%
	Disagree	14	28.0%
	Agree	6	12.0%
	Completely agree	11	22.0%
The occurrence of medical error during robotic surgery is possible and doesn't mean negligence from surgeons in all cases	Neutral	4	8.0%
	Complete disagreeing	2	4.0%
	Disagree	0	0.0%
	Agree	12	24.0%
	Completely agree	32	64.0%
The surgeon is responsible for any postoperative patient complications after robotic surgery, even if he adheres to the guidelines of diagnosing and performing the surgery	Neutral	6	12.0%
	Complete disagreeing	16	32.0%
	Disagree	11	22.0%
	Agree	15	30.0%
	Completely agree	2	4.0%
The patient has no right to sue the surgeon when robotic complications occur, as long as the doctor has obtained the patient's informed consent with explaining all possible complications	Neutral	7	14.0%
	Complete disagreeing	7	14.0%
	Disagree	9	18.0%
	Agree	10	20.0%
	Completely agree	17	34.0%
It is in the surgeon's interest to have a hospital system for reporting a robotic surgical error as soon as the error occurs	Neutral	2	4.0%
	Complete disagreeing	0	0.0%
	Disagree	1	2.0%
	Agree	19	38.0%
	Completely agree	28	56.0%
It is difficult for the surgeon to report to the hospital upon making a mistake regarding robotic surgery	Neutral	7	14.0%
	Complete disagreeing	8	16.0%
	Disagree	19	38.0%
	Agree	9	18.0%
	Completely agree	7	14.0%
The hospital performing robotic surgeries is responsible for its staff performance and is considered liable if there is proven negligence from them	Neutral	3	6.0%
	Complete disagreeing	0	0.0%
	Disagree	5	10.0%
	Agree	15	30.0%
	Completely agree	27	54.0%
The surgeon is held accountable for the robotic errors made by the surgical team and device technicians	Neutral	19	38.0%
	Complete disagreeing	1	2.0%
	Disagree	9	18.0%
	Agree	17	34.0%
	Completely agree	4	8.0%

Table (5): Frequency distribution of medical error occurrence during participation in robotic surgeries of the 23 participated surgeons working at ASU hospitals.

Medical error occurrence during participation in robotic surgeries		No. (%)
Perform robotic surgery on the wrong body part	No	23 (100.0%)
	Yes	0 (0.0%)
Perform robotic surgery on the wrong patient	No	23 (100.0%)
	Yes	0 (0.0%)
Missing a foreign object inside the Patient (e.g., tool, or gauze)	No	19 (82.6%)
	Yes	4 (17.4%)
Organ, vascular or nerve damage	No	13 (56.5%)
	Yes	10 (43.5%)
Infection or contamination	No	20 (87.0%)
	Yes	3 (13.0%)
Inadequate instructions to the patient that resulted in complications	No	21 (91.3%)
	Yes	2 (8.7%)
Improper functioning robotic devices /equipment	No	10 (43.5%)
	Yes	13 (56.5%)
Failure of communication between staff	No	22 (95.7%)
	Yes	1 (4.3%)
Medical error total score	**Median (IQR)**	**1 (1 – 2)**
	Range	**0–4**
Low rate of medical error		**21 (91.3%)**
Moderate rate of medical error		**2 (8.7%)**
High rate of medical error		**0 (0.0%)**

Table (6): Frequency distribution of damage resulting from a medical error, one of the medico-legal issues of robotic surgery, facing the 50 participated surgeons working at ASU hospitals.

Damage resulted from a medical error during robotic surgeries		No.	(%)
▪ Patient death	No	50	(100.0%)
	Yes	0	(0.0%)
▪ Loss of an organ or its function	No	50	(100.0%)
	Yes	0	(0.0%)
▪ Prolonged hospital stays	No	41	(82.0%)
	Yes	9	(18.0%)
▪ Repeated post-operative complaints	No	49	(98.0%)
	Yes	1	(2.0%)
▪ Need for another surgical intervention	No	38	(76.0%)
	Yes	12	(24.0%)

Table (7): Frequency distribution of the action of the 50 participated surgeons working at ASU hospitals upon the occurrence of a medical error as one of the medico-legal issues of robotic surgery.

Participant's action:		No. (%)
▪ Keep the matter secret and tries to hide it from everyone	No	35 (70.0%)
	Yes	15 (30.0%)
▪ Refer the matter to the hospital administration	No	17 (34.0%)
	Yes	33 (66.0%)
▪ Tell the patient what happened	No	25 (50.0%)
	Yes	25 (50.0%)
▪ Avoid performing robotic surgery in the future at all	No	50 (100.0%)
	Yes	0 (0.0%)
▪ Avoid performing robotic surgery in patients with the same condition	No	35 (70.0%)
	Yes	15 (30.0%)

Table (8): Knowledge score, practice, and attitude score, and awareness of medico-legality score regarding robotic surgery for the studied surgeons:

The total score of knowledge	Median (IQR)	4 (4 - 5)
	Range	3 – 5
Unsatisfying		11 (22.0%)
Satisfying		39 (78.0%)
The total score of Practice and attitude	Median (IQR)	40.5 (39 - 45)
	Range	31 – 52
Poor		0 (0.0%)
Good		10 (20.0%)
Excellent		40 (80.0%)
The total score of Awareness of medico-legality	Median (IQR)	39 (34 - 42)
	Range	23 – 50
Poor		3 (6.0%)
Good		39 (78.0%)
Excellent		8 (16.0%)

Table (9): Spearman correlation coefficient between knowledge total score, practice & attitude total score, and awareness of medico-legality total score with each other.

	Knowledge		**Practice & attitude total score**		**Awareness of Medico-legality**	
	r	**P**	**r**	**P**	**r**	**P**
The total score of knowledge	--	--	-0.276	0.053	-0.067	0.642
Practice & attitude total score	-0.276	0.053	--	--	**0.390**	**0.005**
Awareness of Medico-legality total score	-0.067	0.642	**0.390**	**0.005**	--	--

P-value >0.05: Non-significant (NS); P-value <0.05: Significant (S)

Discussion

The growing applications of robotic surgical systems are mandating an understanding of the ethical and legal aspects of their use. There are multiple ethical considerations including respect for autonomy, beneficence, nonmaleficence, and justice (Wightman et al., 2020).

The robotic manufacturer, the surgical team, and the hospitals are at risk of medico-legal compliance in performing robotic surgeries (Hechenbleikner &Jacob, 2019).

This study aimed to evaluate the ethical and medico-legal commitment of the medical staff in robotic surgery at Ain Shams University (ASU) Hospitals.

As regards the characteristics of surgeons participating in this study: the results showed that most of them were males (82%), 62% of surgeons were < 30 years old, and 28% were aged between 30 and 40 years, most of them were assistant lecturers and residents (80%): A percentage of 74% had less than 5 years of work experience. 62% of participants were general surgeons, 20% were Obs& Gynea surgeons and 18% were urology surgeons. 16% of participants had performed one or more operations while 30% assisted the surgeon during the operation.

The results of the current study are similar to the results obtained by a study done by O'Connell et al. (2022) where (74%) of respondents were men, with 34% of respondents in the first 2 years of specialty training and 23% midway through. The majority of respondents had observed (60%) or scrubbed in for (57%) at least 1 robotic-assisted operation and only 14% had performed operations.

A study was done by Aldousari et al. (2018) who conducted a survey distributed among surgeons of different subspecialties and found that general surgeons, urologists, and gynecologists constituted 54%, 23%, and 13%, respectively with a mean age of 36 years and significant association between younger age groups and comfort using the novel technology.

Concerning the ethical awareness of surgeons regarding robotic surgery, the current study showed that (98%) of participants were aware of the patient's rights to refuse to undergo robotic surgery with or without reason and respected the patient's autonomy, 100% knew that informed consent must be taken voluntarily and without undue influence, and only 40% believed that all patients have the capacity to make it.

This result is in accordance with a study done by Althobaiti et al. (2021) who found that 61.8% of participants never engaged in healthcare-related acts on a patient without informed consent.

Inconsistent with the results of the existing study, Al-Shehri et al. (2020) found that only 41% of participants had correct knowledge regarding the principle of autonomy which was assessed by asking whether a patient's wishes must always be adhered to.

This study also presented that 90% of surgeons believed that robotic surgery provides better access to the surgical field than conventional techniques and

34% believed that robotic surgery shouldn't carry any minimal harm to the patient for being applied. 60% of participants considered robotic surgery; like any other surgery, can carry some risks for some patients and is subjected to the benefit-risk ratio before being applied under the scope of the principle of non-maleficence. The results also showed that the fear of harming the patient prevents 30% of participants from training in robotic surgery.

A study done by Turner et al. (2020) also found that surgeons frequently emphasized the benefits of robotic surgical techniques including better visuals, more control, and reduced tremor.

A study done by Aldousari et al. (2018) also found that the majority (73%) of surgeons mostly gynecologists, urologists, and general surgeons agreed with the robotic introduction into surgical practice due to their belief in its enhanced precision and better visualization.

The current results showed that 80% of participants would prefer robotic surgery over conventional surgery if the patient's condition were equal for both.

Khalafallah et al. (2021) found that the total number of robotic general surgery operations using the da Vinci® robot increased 6-fold in 2017 over that in 2013, while open and laparoscopic operations decreased by about 33% during those years.

The current study showed that most participants (82%) selected patients for robotic operation based on their health condition to ensure the highest rate of recovery with the exclusion of critical patients and delayed cases and 78% selected them for taking advantage of their condition in development and scientific research while less than half of participants (40%) considered patients' financial ability without regard to their health condition and patient waiting lists, and 48% select patients by personal preference of the doctor.

The explanation for this result is that robotic surgery is new for application in EGYPT and is wanted to achieve a high score of success with the least possible complications and ambition for the establishment and improvement of this technology.

Duensing et al. (2023) found that 42% of surgeons endorsed that financial conflict of interest influenced a surgeon's decision to utilize robotics.

Angelos (2020) stated that the operative technique recommended for a patient depends on the surgeon's judgment regarding the likelihood of success with it.

A study done by Aldousari et al. (2018) found that faster recovery, lower complications, and patient demand were the most important factors affecting surgeons' decisions when choosing robotic surgery.

Regarding the conditions validating informed consent for robotic surgery and its details, the current study showed that all participants took written informed consent from the patients before undergoing robotic surgeries.

Haripriya & Haripriya, (2014) found that all participants were aware of different types of consent, and they considered that informed consent is best among all.

The current study showed that 100% of participants favored explaining the impact of using the surgical robot on the operation time compared to conventional methods, (96%) favored explaining all robotic surgical details and complications for patients even if they are so bad, (88%) endorsed the importance of providing patients with information about the surgeon's experience in robotic surgery, and (82%) affirmed informing the patient about the success rate of relevant robotic surgeries carried out in EGYPT.

Char et al. (2013) found that approximately 80% of patients indicated they could not decide on surgery without being informed whether the surgeon was performing the procedure for the first time while 60% of surgeons believed this information was essential.

The present study clarified that 50% of participants advocated the possibility of breaching confidentiality by disclosing patients' private information within earshot of others who are not involved in the patient's care at the work unit.

The current study results are in contrast with a study done by Tekleab and Lantos (2022) who reported that scores of physicians were highest on questions about maintaining confidentiality (94.9% correct):

Regarding conflict of interest, the current study clarified that 50% of the participants confirmed informing the patient if using a robotic device is merely a personal preference of the doctor, only 4% validated using robotic devices in operations for research and development without the patient's permission for the purpose of benefiting other patients, and (86%) affirmed the possibility of photographing robotic operations for marketing through social media as long as the patient agrees.

Wightman et al. (2020) stated that if robotic surgery is recommended for the surgeon's preference, robotic skill development, or the comfort of the surgeon, this should be disclosed to the patient.

The current study showed that most participants (88%) denied overestimating expectations of the results of robotic operations for encouraging the patient to undergo this operation. 10% of participants thought that robotic surgery would decrease doctors' liability rate. All participants (100%) supported the importance of a surgeon's training in conventional surgical techniques besides robotic techniques for the benefit of the patient.

This result coincides with Hechenbleikner & Jacob (2019) who stated that the FDA has approved the da Vinci® Surgical System as a class 2 medical device meaning that it is a device with a small but real possibility of causing harm to patients increasing the surgeon's liability for malpractice.

This result coincides with the study done by Farivar et al. (2015) who found that about 64% of general surgery residents reported that formal training in robotic surgery was important in residency and 46% of residents indicated that robotic-assisted cases interfered with resident learning. Only 11% felt that

robotic surgery would replace conventional surgery in the future.

The current study showed that almost all (98%) of participants considered that the patient's consent before robotic surgery is protection for the surgeon. However, only 22% of participants supported the patient's right to sue the surgeon if the patient is harmed due to advice about robotic surgery published on social media, and 34% of participants advocated the patient's right to sue the surgeon if the patient was harmed by publishing his robotic surgery on social media even if he made informed consent.

Metwally et al. (2021) reported that the practice of informed consent is common within the Egyptian medical community. 65% of participants take informed consent for the purpose of documenting patients' decisions. 65% of participants believe that information disclosure to patients is a must to help in informed decision-making.

The current study showed that most of the participants (88%) endorsed that the occurrence of medical error during robotic surgery is possible and doesn't mean negligence from surgeons in all cases, while only 34% of the participants confirmed that the surgeon is responsible for any postoperative complications.

This result could be attributed to surgeons' belief that following the guidelines for diagnosing and performing the surgery protects them from robotic liability in case of unfavorable outcomes. So, patients lose the right to sue the surgeon. (Personal communication)

The results also were supported by Hechenbleikner & Jacob (2019) who stated that when a robotic surgery results in an undesirable outcome, liability can fall on either the surgeon performing the surgery, the hospital, the manufacturer of the robotic system, or all of them.

The current study showed that more than half (54%) of surgeons were convinced that the patient has no right to sue the surgeon when robotic complications occur, as long as the doctor has obtained the patient's informed consent.

This result indicates that surgeons did not have a clear understanding of the true concept of informed consent. Instead, they approached it as if it is a general permission for all procedures and their outcomes.

Nath et al. (2022) found that only 21.2% of medical officers had adequate knowledge regarding informed consent.

A study done by Makhni et al. (2018) to analyze spine surgery malpractice cases found that insufficient informed consent was cited in 34% of medico-legal cases.

The current study showed that most surgeons (94%) confirmed that it is in the surgeon's interest to have a hospital system for reporting a robotic surgical error as soon as it occurs. However, 32% confirmed the difficulty of reporting to the hospital upon making a mistake. (84%) endorsed the hospital's responsibility for its staff performance and it is considered liable if there is proven negligence by them. 42% affirmed the accountability of surgeons for the robotic errors made by the surgical team and device technicians.

Jamjoom et al. (2022) reported that when a patient came to harm by the surgeon controlling the robotic system, (67.6%) of respondents blamed the surgeon and considered him the most responsible party as he is the primary decision-maker across all parts of the patient management approach. But when a patient is harmed by a smart robotic telescope providing inaccurate information to the surgeon, the majority of respondents (69.6%) considered the robot manufacturer was most at blame despite the surgeon being the primary decision maker for the patient's management.

Hechenbleikner & Jacob (2019) supported this finding, stating that bedside assistants are liable and at risk for medico-legal lawsuits despite being under the hospital's and surgeon's responsibility, as the surgeon is considered the leader of the team.

The current study showed that 46% of participants performed or assisted the surgeon during robotic operations; (17.4%) of them were about to miss a foreign object inside the patient (e.g., tool, or gauze), (43.5%) of them caused organ, vascular, or nerve damage, and 13% of them experienced infection or contamination during robotic surgeries. only (8.7%) gave inadequate instructions to the patient which resulted in complications, (56.5%) experienced a mistake due to improper functioning robotic devices /equipment during robotic surgeries and (4.3%) experienced failure of communication between staff. The medical error total score ranged from 0 to 4 with a Median (IQR) of 1 (1 – 2): None of the participants experienced either patient death or loss of an organ or its function, only 18% experienced prolonged hospital stays and only 2% experienced repeated post-operative complaints with their patients after robotic operations. 24% of surgeons needed to perform another surgical intervention by turning the robotic technique to the conventional method.

Buchs et al. (2014) found that the robotic malfunction rate was low, and only occurred in (3.4%) of cases. 2/3 of them were considered critical, and one-third led to a laparoscopic conversion (conversion rate due to malfunction, 0.2%):

Ahmad et al., (2017) found that (62.42 %) of respondents believed that robotic surgery lowered the infection rate, while 33.94 % believed it had no effect, and 37.90 % believed it had a lower risk of complications. 86.21 % of healthcare providers believed that robotic assistance improved precision and accuracy for the surgeon.

The current study showed that upon the occurrence of a medical error that has been remedied during robotic surgeries, only 30% of participants would keep the matter secret and tries to hide it from everyone while 66% of participants would refer the matter to the hospital administration and 50% of participants would tell the patient what happened. There is an overlap between the percentage of participants who wouldn't keep the matter secret as some of them would tell the patient without telling the hospital and vice versa. Regarding defensive medicine,

none of the participants would avoid performing robotic surgery in the future at all after the occurrence of a medical error while 30% of them would avoid performing robotic surgery on patients with the same condition. Furthermore, none of the participants (0%) has been accused of making a medical error during robotic surgery.

Pinto et al. (2013) found that around 33% of surgeons surveyed reported that their institutions tended to adopt a punitive and blame-oriented approach toward complications. More than two-thirds of participants expressed their opinion that their employing organizations' support is not sufficient, and a lot of criticism was shown at morbidity and mortality meetings. It has been said that these meetings are dominated by a culture of blame and cover-up. Among the 27 participants, 935 reported that their problem-focused coping strategy was discussing their issues with peers in order to seek advice. The majority reported that they turn to their peers for support as they are easily accessible and the most sought-after source of help.

The current study showed that 78% of participants had satisfying knowledge of ethics regarding robotic surgery with a total score ranging from 3 to 5 with a Median (IQR) of 4 (4-5): 80% of participants had excellent practice and attitude while 20% had good practice and attitude regarding the ethics of robotic surgery. 16% of participants had excellent awareness of medico-legality while 78% of the participants had a good awareness of it.

A study done by Bazmi et al. (2023) on 112 surgery residents from six teaching hospitals in the capital city of a developing country (Tehran/Iran)., found that their mean knowledge score for medical ethics was 3.26±0.53 out of 5 and the mean awareness score for medical law was 3.69±0.69.

In a study done by Rehman et al. (2022), the majority of doctors either agreed (70%) or strongly agreed (30%) that they displayed positive attitudes towards patients and the medical profession. Also, the majority of the doctors stated that they had always (53%) or often (39%) adopted good ethical practices and could deal with medical errors professionally.

This result is in contrast with a study done by Zaed et al. (2021), who found a low level of awareness of medico-legal issues among Italian neurosurgeons.

The current study found a positive correlation between the total score of practice & attitude of surgeons regarding robotic surgery and the awareness of medico-legality total score.

These findings are consistent with the fact that surgeons performing robotic surgery with adequate scores of their practice and attitude toward patients would more likely have faced a lot of problems including medico-legal issues that increased their medico-legal awareness. This might be due to the reason that with the increase in exposure, awareness also increases as concluded by a study done by Haripriya & Haripriya (2014).

Rehman et al. (2022) concluded that in the medical profession, both knowledge and attitudes toward ethics decide the level of practicing of ethical principles. This is because adequate knowledge and positive attitudes toward ethical principles can equip healthcare professionals to handle, cope with, and overcome ethical challenges and medico-legal issues that may arise during routine clinical practice.

Conclusion

The current study concluded that nearly 80% of surgeons working at ASU hospitals have satisfying knowledge of ethics, excellent practice and attitude, and a good awareness of medico-legal issues, medical errors, and damage from robotic surgery. There was a positive correlation found only between the surgeons' practice & attitude towards robotic surgery and their awareness of robotic medico-legal issues.

Recommendations

The current study suggests that:

- Ethical and medico-legal training courses should be held at regular intervals in ASU hospitals, especially for surgical specialties.
- Encourage the robotic surgeons to stick to ethical principles to organize the provision and development of the new technology and preserve the rights of patients and surgeons.

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الجراحة الروبوتية على حافة الأخلاقيات والمُساءلة الطبية:

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الملخص العربي

خلفية: تعتبر الجراحة الروبوتية واحدة من أحدث التقنيات المستخدمة في الجراحة على أمل تقليل الألم والوقت الذي يقضيه المريض في التعافي حيث يمكنها إجراء تقنيات جراحية معقدة من خلال فتحات صغيرة، تاركة ندوبا بسيطة جدا. ويوجد العديد من الأنظمة الجراحية الروبوتية قيد الاستخدام حاليا لكن نظام دافنشي® الجراحي هو الأكثر شيوعا. يستلزم الاستخدام المتزايد لأدوات الجراحة الروبوتية فهم الجوانب الأخلاقية والقانونية المتعلقة باستخدامها حيث توجد اعتبارات أخلاقية متعددة بما في ذلك احترام استقلالية المريض، وعدم الإضرار والعدالة بين المرضى. وتعتبر الشركة المصنعة للروبوت والفريق الجراحي والمستشفيات من أصحاب المصلحة المعرضين لخطر الامتثال للقوانين الطبية عند إجراء العمليات الجراحية الروبوتية. مع التوسع في استخدام الجراحة الروبوتية، يجب على الجراحين ضمان حصول المرضى على علاج عادل ومعقول يحترم حقوقهم الإنسانية وكرامتهم. **الهدف من الدراسة:** تهدف هذه الدراسة إلى تقييم الامتثال الأخلاقي والقانوني للطاقم الطبي عند تطبيق الجراحات الروبوتية بمستشفيات جامعة عين شمس. **المشاركون والأساليب:** تم استخدام استبيان مصمم ذاتيا لجمع البيانات اللازمة لتحقيق هدف الدراسة من قِبل أطباء الجراحة العامة وجرّاحي المسالك البولية وأطباء النساء والتوليد العاملين في مستشفيات جامعة عين شمس، خلال الفترة من يونيو 2022 إلى ديسمبر 2022. **النتائج:** أوضحت الدراسة الحالية أن 78٪ من المشاركين لديهم درجة مُرضية من المعرفة بالأخلاقيات الطبية بمجموع درجات تتراوح من 3 إلى 5 مع متوسط (IQR) من 4 (4-5). 80٪ من المشاركين لديهم ممارسة وموقف ممتاز بينما كان لدى 20٪ ممارسات ومواقف جيدة فيما يتعلق بأخلاقيات الجراحة الروبوتية. وكان لدى 16٪ من المشاركين وعي ممتاز بالقوانين الطبية الشرعية بينما كان لدى 78٪ منهم وعي جيد به. وقد وجدت هذه الدراسة علاقة إيجابية بين النتيجة الإجمالية للموقف والممارسة الطبية وبين الدرجة الإجمالية للوعي بالطب القانوني. كما كانت هناك علاقة ذات دلالة إحصائية كبيرة بين النتيجة الإجمالية للوعي بالقوانين الطبية الشرعية ومدى مشاركة الجراح في العمليات الروبوتية. بينما لم تكن هناك علاقة ذات دلالة إحصائية بين معرفة وممارسة وموقف الجراحين الذين يشغلون أنظمة روبوتية ببياناتهم الديموغرافية باستثناء خبرتهم العملية. وقد تراوحت النتيجة الإجمالية للخطأ الطبي من 0 إلى 4 مع متوسط (IQR) 1 (1 - 2). **الخلاصة:** معظم الجرّاحين العاملين بمستشفيات جامعة عين شمس لديهم درجة مُرضية من المعرفة فيما يتعلق بأخلاقيات الجراحة الروبوتية كما أن لديهم ممارسة وموقف مقبول ووعي جيد بالقضايا الطبية القانونية والأخطاء الطبية والأضرار الناجمة عن الجراحة الروبوتية ويفضلون الجراحة الروبوتية على الجراحة التقليدية في المستقبل. **التوصيات:** توصي الدراسة الحالية بعقد دورات تدريبية أخلاقية وطبية قانونية على فترات منتظمة في مستشفيات جامعة عين شمس، خاصة للتخصصات الجراحية .تشجيع الجراحين على الالتزام بالمبادئ الأخلاقية للمساعدة على توفير وتطوير التكنولوجيا الجديدة والحفاظ على حقوق المرضى والجراحين.

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