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ORIGINAL ARTICLE

Robotic Surgery in Gynaecology: A Retrospective Evaluation of an Experience at a Single Centre

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Abstracts

Objective The aim of this research was to assess the role of robotics and its outcome in gynaecology both in benign and malignant cases in a single centre and provide a critical evaluation of possible advantages of robot assisted surgeries from surgeons' point of view.

Design A single centre, retrospective observational study.

Population All women who underwent robotic gynaecological surgeries between 2015 and 2022.

Methods The Da Vinci Si™ robotic system was used for these surgeries performed by all surgeons at our quaternary care centre, and data were acquired retrospectively through electronic medical records. Descriptive statistical analysis of data was done. Main outcome measures included operative time, estimated blood loss, hospital stay, complications and conversion rates in all cases. Age was analysed as a demographic data.

Outcome A total of 211 robotic cases were performed including 172 hysterectomies, 20 myomectomies and 19 cases for other gynaecological indications. The mean operating time or hysterectomy and myomectomy was 113 and 129 min, respectively, and haemoglobin drop was 1.34 and 1.2 g/dl, respectively. No conversions to laparotomy were observed in either of the groups. The surgeries for 19 benign gynaecological conditions included ovarian cystectomy, cesarean scar repair and chronic cornual ectopic.

Conclusion Robotic surgical system helps accomplish several procedures with exceptional laparoscopic skills. Robotic surgery is safe in all types of gynaecological procedures and is a promising alternative for comprehensive gynaecologic surgical care.

Keywords Hysterectomy · Laparoscopy · Robotic · Myomectomy · Cystectomy

Introduction

The use of robotics in surgery was hypothesised as far back as 1967 and has evolved continuously with the development of first fully functional multipurpose surgical robot over 30 years ago, to the currently available US FDA approved multipurpose robotic surgery system—Intuitive Surgical Inc.'s Da Vinci™ Surgical System, which is found in operating rooms across the globe.

The introduction of robots for assistance in gynaecological surgery, with particular reference to the Da Vinci™ Surgical System, has been a ground breaking discovery, which has changed the way gynaecologic procedures are carried out [1, 2]. The Stanford Research Institute developed Da Vinci™ system initially so that surgeons could operate remotely on wounded soldiers via the means of telesurgery [1, 2]. However, today the scenario is that of the surgeon

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operating on the patient being in the same room but on an ergonomically designed console, viewing the surgical field in a 3D vision and manipulating the wristed laparoscopic instruments through the masters and foot pedal [2]. The US FDA approved the system for use in gynecology in 2005 based on the data and reports of safety and efficacy in studies conducted for cases of myomectomy and hysterectomy at the University of Michigan [1, 2]. Currently, applications in gynecology include but not limited to hysterectomy, myomectomy, oophorectomy, and ovarian cystectomy, resection of endometriosis, sacrocolpopexy and lymphadenectomy. The use of robotic assistance in laparoscopy is gaining popularity due its ability to overcome difficulties of conventional laparoscopy while allowing patients to benefit from minimally invasive surgery [2, 3].

The purpose of this article is to critically assess the role of robotics and its outcome in gynaecology both in benign and malignant cases in a single quaternary care centre.

Methods

Study Design

This was a retrospective observational study conducted at Aster Medcity, Kochi, a 670 bedded NABH accredited quaternary care centre in Kerala, India, from 2015 to 2022. Preoperative work up was the same as routinely done for any gynaecological procedure. The procedures were performed by four surgeons with extensive experience in advanced laparoscopy. Case selection criteria were the same as that for any other laparoscopic procedure. Informed written consent was taken for conversion to laparoscopy/laparotomy in all cases.

We used a three arm Da Vinci Si™ robotic system.

We standardised the port positions as.

1. A 12 mm optical (primary) port-2 cm above the umbilicus.
2. An 8 mm robotic port (converted to 5 mm with washer) on either side placed 10 cm lateral and 12 cm caudal to the primary port with minimum 8 cm gap between the ports. The right sided robotic port was a mirror image of the left robotic port.
3. One assistant 5 mm port was placed at the level of the camera port on the right side. The robotic cart was docked on the left side of the patient.
4. A 0-degree scope was used for the procedure.

For all the surgeries, the following primary outcome parameters were analysed:

1. Robotic docking time.
2. Surgical time (mean operating time -MOT)
3. Blood loss in terms of haemoglobin (Hb) drop in g/dl
4. Complications in terms of bowel, bladder and ureteric injuries and need for blood transfusion during preoperative/intraoperative/post-operative periods were noted.
5. Conversion to either conventional laparoscopy or laparotomy.
6. Length of hospital stay (days).

Secondary outcome measures in myomectomy cases included the size and number of the fibroids removed, and average weight of the myoma/s removed per case.

Statistical Analysis

Descriptive statistical analysis was performed. Mean and standard deviation were used for continuous data wherever applicable.

Results

We had a total of 211 gynaecological cases performed using the Da vinci Si™ at our institute. One hundred seventy-two were total hysterectomies for various complex pathologies including big fibroids, endometriosis, premalignant lesions including ASCUS CIN (1, 2, 3) and early-stage endometrial cancer. Twenty cases of myomectomy included all types of fibroids (subserosal intramural, submucous and broad ligament). Out of the remaining 19 surgeries performed, 17 cases included indications for cystectomy or salpingo-oophorectomy and one case each of caesarean scar repair and chronic cornual ectopic. Of the total 172 hysterectomies, 167 were for benign conditions and 5 were malignant cases of carcinoma endometrium (Stage. 1A). Pie distribution of the indications for hysterectomy in Fig. 1 (top image) with further details analysed in Table 1 shows that 57% of cases were performed for fibroid uterus of which 9% of women had associated grade 2–3 endometriosis. Demographic data as seen in Fig. 1 (bar graph, bottom image) showed an average age of patients to be 46.7 years in the hysterectomy group and 34.65 and 36.3 years in the myomectomy and other surgeries groups, respectively.

Table 2 analyses these cases along with primary outcome parameters.

As seen in Table 2, mean operating time (MOT) for hysterectomies was 112 min in benign group versus 120 min in malignant group. The average operating time for robotic myomectomies was 129 min whereas for remaining benign adnexal pathologies it was 91 min. In all these surgeries, the docking time was previously 30 min which later reduced to 15 min because of standardisation of ports, team gaining

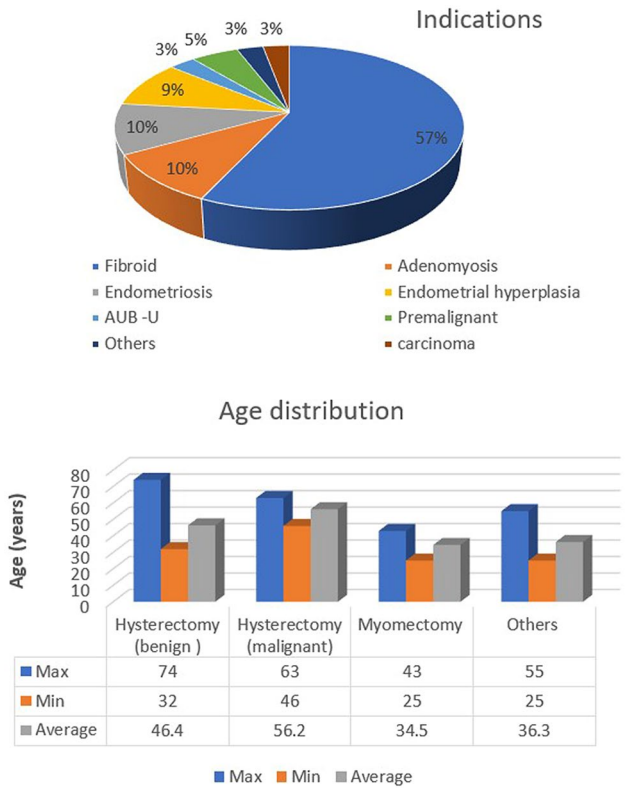

Fig. 1 Top image shows the pie distribution of the indications for robotic hysterectomies performed at our institute between 2015–2022. Bar graph below shows the age distribution across the subsets. Data shown as mean and range

experience and getting acquainted with the system. There were six urological complications including four cases of bladder injury with primary repair and two cases requiring ureteric reimplantation in the hysterectomy for benign causes group. There were five cases of bowel injury (sigmoid colon) requiring repair and one case of pulmonary embolism in the post-operative period in the benign group. There were no conversions to laparotomy. The average size of the uteri removed were 16–18 weeks with two cases having uterus > 22 weeks size. There were five cases in the malignancy group indication for all being carcinoma of the endometrium four of which were stage IA and one was stage IB. All cases underwent staging procedure with radical hysterectomy with bilateral salpingo-oophorectomy and pelvic lymph node dissection. The mean operating time was 120 min with mean haemoglobin drop of 1.5 g/dl. There were no major complications, and none were converted to laparotomy.

Table 1 Indications for hysterectomies performed at our Institute (2015–2022)

Diagnosis	No. of cases
Fibroid	89
Fibroid with endometriosis (grade2–3)	9
Adenomyosis ± endometriosis	17
Abnormal uterine bleeding-Unclassified	5
Endometriosis stage 3–4	17
Endometrial hyperplasia without atypia	10
Endometrial hyperplasia with atypia	6
CIN high grade/AGUS	9
Carcinoma endometrium (stage IA and stage IB)	5
Others (hydrosalpinx/TO abscess)	5
Total	172

We had 20 cases of robotic myomectomies with almost all fibroids between the range of 16–18 weeks gravid uterus size. Two fibroids were 18–20 weeks and 20–22 weeks size weighing 1.26 and 1.56 kg, respectively. Two cases had myomectomy with additional procedure of unilateral ovarian cystectomy for endometriotic cyst and dermoid cyst, respectively, and one case had unilateral salpingectomy. Out of the 20, we had one case each of broad ligament fibroid and a submucous fibroid where cavity was entered, six cases each of posterior wall intramural fibroid and subserosal fibroid. Six women had multiple fibroids with subserosal and intramural components. The average number of fibroids removed was 2.4 (1–5), with mean diameter of 6.04 ± 3.1 cm (3.5–15 cm), and average weight of myomas was 219.6 ± 364 g (21–1560 g). There were no major complications or conversions to laparotomy.

The other group of 19 cases included five cases of ovarian cystectomy for endometriosis (stage III–IV), six cases of bilateral salpingo-oophorectomy for post-hysterectomy ovarian cyst, three cases of unilateral ovariotomy for dermoid cyst of ovary, two cases of paraovarian cystectomy and one case each of unilateral salpingectomy for chronic cornual ectopic, isthmocele excision for cesarean scar repair and unilateral salpingoovariotomy for tubo-ovarian abscess. The complications in this group included one ureteric reimplantation during ovarian cystectomy for endometriosis associated hydroureteronephrosis (HUN) and one sigmoid colon tear repair during adhesiolysis for post-hysterectomy ovarian cyst. There were no conversions to laparotomy. The mean operating time was 91 min.

Estimated blood loss (EBL) was calculated in terms of postoperative haemoglobin (Hb) drop in g/dl, and a mean drop of 1.34, 1.2 and 1.1 g/dl was noted in the hysterectomy, myomectomy and other surgeries groups, respectively. Six patients in the benign hysterectomy group received PRBC transfusions of which two were intraoperative and four were postoperative. These patients had a baseline anaemia and hence received prophylactic transfusions to avoid postoperative morbidity due to anaemia. The details of the cases with complications are presented in Table 3.

The average length of hospital stay (LOS) was 4 days in the hysterectomy, 3 days in myomectomy patients and 2 days for the other subset. No statistical tests of significance were required.

Table 2 Distribution of cases along with analysis of main outcome parameters in our study. Data were shown as mean ± SD, range

Parameter/procedure	Hysterectomy (benign)	Radical hysterectomy (malignant)	Total hysterectomies	Myomectomy	Others
Mean Age (years)	46.7 ± 6.3 (32–74)	56.2 ± 6.3 (46–63)	46.7 ± 6.5 (32–74)	34.65 ± 5.1 (25–43)	36.3 ± 7.5 (25–55)
MOT (minutes)	112 ± 46 (40–240)	120 ± 37 (90–180)	113 ± 45 (40–240)	129 ± 31 (90–180)	91 ± 35 (30–180)
EBL (Hb drop g/dl)	1.33 ± 0.80 (0.1–3.6)	1.58 ± 0.54 (1.1–2.3)	1.34 ± 0.79 (0.1–3.6)	1.2 ± 0.6 (0.4–2.4)	0.98 ± 0.58 (0.1–2.3)
LOS (days)	4(2–11)	4(3–5)	4(2–11)	2	2
Complications	Major 11/167 Post-op 1	None	Major 11/172 Post-op 1	None	Major 2/19
Conversions	None	None	None	None	None
Total no of cases (211)	167	5	172	20	19

Table 3 Cases with complications and details in terms of age, operative time, haemoglobin drop and duration of stay and management

Diagnosis	Procedure	Complication	Age	Hb drop (g/dl)	MOT (minutes)	Management	Hospital stay (days)
Fibroid uterus	RH with BS	Bladder adhesion injury	44	0.6	150	Bladder repair	4
Multiple fibroid uterus	RH with BS	Bowel injury	49	2.2	180	Bowel serosal repair & DJ stenting	8
Cervix CIN 2	RH with BSO	Bowel injury	33	1.4	180	Bowel serosal repair & DJ stenting	8
Endometriosis grade 4	RH with BSO	Ureteric transection	38	2	210	Vesico ureteric anastomosis	4
B/L TO mass	RH with BSO	Dense adherent bladder injury	40	1.5	90	Primary closure of bladder injury	3
Fibroid uterus with ventral hernia	RH with BSO with hernia repair	Bladder injury	43	2.1	100	Primary repair of injury	4
Fibroid uterus with grade 3 endometriosis	RH with BSO	Dense adhesions distorting ureteric anatomy	43	0.6	180	Adhesiolysis with DJ stenting	4
Fibroid uterus with grade 2 endometriosis	RH with BSO	Adherent Bladder	46	0.5	240	Cystoscopy	4
Fibroid uterus with b/l grade 4 endometriotic cyst	RH with BSO	Sigmoid colon injury	43	0.7	240	Bowel repair & DJ stenting	8
AUB-adenomyosis with b/l endometriotic cyst	RH with BSO	Adherent bladder, dome injury	45	0.7	100	Bladder dome repair	6
Grade 4 endometriosis	RH with BSO	Bowel-rectum injury, right ureteric injury				Bowel repair, DJ stenting, Right ureteric reimplantation	8
Left ovarian endometriotic cyst with HUN	ovarian cystectomy	Ureteric injury	31	0.6	120	Ureteric reimplantation	3
Post-hysterectomy ovarian cyst	ovarian cystectomy	Sigmoid colon tear	34	1.6	90	Tear repair	4

RH robotic hysterectomy, *BSO* bilateral salpingo-oophorectomy

Table 4 Comparative data of total robotic hysterectomies with previously reported series [2, 3, 5–7] (Data were shown as mean ± SD, range)

Author Variable	Our study	Reynolds and Advincula [5]	Payne et al. [6]	Shashoua et al. [2]	Sarlos et al. [7]	Giep et al. [8]	Puntambekar et al. [3]
No of cases	172	16	100	24	40	237	24
Duration of study	2015–2022	2001–2004	2006–2007	2005–2007	2007–2009	2007–2009	2012–2013
Operative time (min)	113 ± 45 (40–240)	242 (170–432)	119	142	109	90	80
EBL (Hb drop)(g/dl)/ml	1.34 ± 0.79 (0.1–3.6)	96 (50–300)	61	1.9	<50	59	20
LOS (days)	4 (2–11)	1.5	1	1	3.1	1	1
Intraop complications	11/172	5/16	1/100	None	None	1/237	None
Post-op complications	Major 1/172 Minor 6/172	Major 2/16 Minor 4/16	Major None Minor 1/100	Major None Minor 1/24	Major None Minor 5/40	Major None Minor 6/237	Major None
Conversion rates	None	None	4%	None	None	1.7%	None

Discussion

Main Findings

A comparative analysis of the outcomes of our study with those of previously done standard studies shows comparable results for hysterectomy and myomectomy subsets as shown in Tables 4 and 5, respectively. We hereby present a review of previous studies below.

One of the earliest experiences of robot assisted laparoscopic hysterectomy was reported in a study by Diaz-Arrastia and colleagues in 2002, which included 16 patients from 27 to 77 years of age. The study reported duration of surgery from 270 to 600 min and blood loss 50–1500 ml with an average of 300 ml. Mean hospital stay was 2 days and ranged of 1–3 days [1–4].Numerous reports have followed after that analysing the role of robotics in minimal invasive surgery and so have the advances in the technology.

Reynolds and Advincula [5] published a case series of 16 patients in a university hospital who underwent robotic-assisted laparoscopic hysterectomy and outcomes of their study were supportive of our analysis. One patient experienced a delayed thermal bowel injury, 2 developed postoperative infections, and one developed a vaginal cuff hematoma that was managed expectantly [2, 3, 5].

Payne et al. [6] in a retrospective analysis of cases of total 200 patients from 2004 to 2007, comparing 100 patients each in the conventional laparoscopy hysterectomy and robotic cohort and mean operative time, blood loss and mean hospital stay in robotic cohort were significantly lower than that in the conventional laparoscopy group. No conversions to laparotomy were made in the robotic cohort. They concluded that robotic hysterectomy was quicker and with less risk for abdominal conversion than standard laparoscopy as was seen in our study [2, 3, 6].

A retrospective analysis comparing conventional laparoscopy with robotic-assisted hysterectomy by Shashoua et al. [2] demonstrated a shorter hospital stay and a significant decrease in narcotic use with robotic hysterectomy. Blood loss in terms of drop in haemoglobin was not significantly

Table 5 Comparative of data of robotic myomectomies with previously reported series [5, 8, 9] (Data were shown as mean ± SD, range)

Author Variable	Our study	Advincula et al. [5]	Cheng et al. [8]	Lee et al. [9]
No of cases	20	35	22	74
Duration of study	2015–2022	2001–2004	2010–2012	2012–2017
Operative time (min)	129 ± 31 (90–180)	230.8 ± 83	278.6 ± 67.0	225.0 ± 82.7
EBL(mean) (Hb drop)(g/dl)/ml	1.22 ± 0.6 g/dl (0.4–2.4)	169 ± 198 ml	235.7 ± 283.3 ml	309.4 ± 190.3 mL
Mean myoma weight (g)	219.6 ± 364.6 (21–1560)	223 ± 244	367.4 ± 317.7	327.9 ± 206.8
Mean number removed	2.4(1–5)	1.6	3.1 (1.0–17.0)	2.9
Mean diameter(cm)	1.04 ± 3.1 (3.5–15)	7.9 ± 3	7.3 ± 3.5	9.2 ± 2.8
LOS (days)	2	1	3.1 ± 0.9	2
Intraop complications	None	1	1/22	NA
Post-op complications	None	3	NA	NA
Conversion rates	None	8.6	None	None

different. The operative duration was significantly longer in patients undergoing robotic hysterectomy. However, only due to need for laparoscopic morcellation, high BMI, and uterine weight, and not robotic use [2, 3].

Sarlos et al. [5] in their prospective matched case controlled study between 2007 and 2009 analysed 40 cases who underwent robotic hysterectomy for benign conditions and concluded that postoperative outcome was similar to conventional total laparoscopic hysterectomy, but operating time were significantly longer in the robotic group owing to the surgeons learning curve [2, 3, 5].

A retrospective analysis by Giep et al. [7] of 237 robotic hysterectomies conducted between 2007 and 2009 at their institution comparing them with laparoscopic assisted vaginal hysterectomy and total laparoscopic hysterectomy concluded that outcomes with robotic surgery were as good as or even better than conventional laparoscopy and operative time for robotic-assisted hysterectomies may continue to improve beyond the initial patient series despite the increased complexity of cases undergoing this procedure [3, 7].

In the Indian experience with robotics, Puntambekar et al. [3] retrospectively analysed 24 cases of robotic hysterectomies for benign pathology retrospectively and had similar outcomes as seen in our study [3].

Comparative Data (Total Robotic Hysterectomy)

See (Table 4).

Robotic Myomectomy

One of first series of myomectomy that was reported in the literature using the Da Vinci robot was by Advincula et al. [5], in 35 patients and the outcome measures in our study in terms of mean diameter of fibroids, mean weight and average number of fibroids removed at the time of surgery were comparable. The conversion rate from robotic to laparotomy was 8.6%, comparable to that of conventional laparoscopic myomectomy unlike in our study which had no conversions to laparotomy. Average operative time and blood loss were lower in our study. As surgical experience increased the operative times decreased [2, 5, 9, 10].

A study by Cheng et al. [8] between 2010 and 2012 analysed 22 cases and the mean operating time and hospital stay was higher than that observed in our study.

Another retrospective study at a tertiary centre in Taiwan by Lee et al. [9] between 2012 and 2017 analysed 74 patients including 32 (43.2%) with large uterine myoma. Perioperative complications were rare with no conversions, and they concluded that robotic myomectomy was feasible for managing large uterine myomas and was a safe procedure with acceptable longer operative time [8, 9].

Comparative Data (Myomectomy)

The main indication for robotic surgery is stage IV endometriosis. A significant number of our patients had stage III endometriosis (15 out of 17 cystectomies/ovariotomy) and the rectosigmoid adhesions and ureter could be separated well due to the high magnification and the intuitive movements of the robot and excellent gastro and urological assistance. We had one ureteric transection managed with ureteric reimplantation. The blood loss was less compared to laparoscopy in adnexectomy.

Margrina et al. [11] retrospectively analysed 85 patients who underwent robotic adnexectomy (unilateral/bilateral salpingo-oophorectomy) for adnexal mass between 2003 and 2008 at Mayo Clinic Arizona and study showed a mean operative time of 83 min (45–193) estimated blood loss 39 ml (10–200) and hospital stay of 1 day which was comparable with the laparoscopy group with a longer operative time (12 min more) in the robotic group. Post-operative recovery was significantly better in the robotic group [11].

A report published by Frick et al. [2] described 2 cases of ureteral obstruction secondary to endometriosis managed with robotic-assisted laparoscopic partial ureterectomy and ureteroneocystostomy [2]. In a similar paper, Nezhat [12–14] and group described successful management of endometriosis of bowel, bladder and ureter in 5 patients using robotically assisted laparoscopic surgery [2, 12–14].

Interpretations

1. Thus, our results for robotic hysterectomy, myomectomy and adnexal surgeries in terms of operative time, estimated blood loss, hospital stay were comparable with most of the standard international studies and better than some of the other studies [3, 11].
2. The rate of complications during hysterectomy seems to be higher in our study and can be justified by the complexity of the cases operated. The operating surgeons had an extensive experience in laparoscopic hysterectomies with which they had started doing Robotic hysterectomies.
3. The average number and weight of myomas removed during myomectomy were comparable with other standard international studies.

Strengths

The strengths of this study include meticulous data collection with all records derived from a real-time updated electronic database, thereby minimising the possibility of bias.

However, there are a few limitations in our study.

1. Limited statistical analysis. Some variables could not be analysed due to lack of information. The number of malignant cases analysed were less.
2. Since clinical follow up is ongoing, recurrence of myoma and fertility rate after operation have not been included in the study.
3. A comparative analysis of conventional (open) versus robotic and laparoscopic versus robotic surgeries is necessary for better evaluation of the possible advantages and limitations of one method over another.

Conclusion

Robotic surgery helps accomplish many procedures with exceptional laparoscopic skills. It is safe in all types of gynaecological procedures and is a promising alternative for comprehensive gynaecologic surgery, including severe endometriosis secondary to three-dimensional visualisation, decreasing surgeon's fatigue and hand tremors and improving surgical precision. Robotic myomectomy is advantageous as compared to an open approach and has extended the boundaries for minimal invasive myomectomy.

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Author Contribution BS and JS contributed to data collection and management, data analysis, writing and editing the article. KM contributed to conceptualisation, protocol development visualisation, supervision, writing—review and editing the article.

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Declarations

Conflict of interest The authors declare that they have no conflict of interest.

Ethical Approval The study was performed following the principles of the Declaration of Helsinki and its modifications. Data were obtained from medical records and de-identifed, with no direct participation of patients.

Informed Consent This was a retrospective observational study. The Institutional Research Ethics Committee has confirmed that no ethical approval is required and patient consent is waived.

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