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RESEARCH ARTICLE

Jain Point entry to avoid trocar injuries in multiple previous surgeries: A retrospective analysis of 720 cases.

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ABSTRACT

Background: Laparoscopic entry in previous surgery cases has several challenges but complexity rises further in patients with a history of multiple previous surgeries leading to intra-abdominal adhesions, visceral, vascular, and nerve injuries, dilemma in port placement, difficulty in establishing pneumoperitoneum, reduced visibility and all these leading to longer operative time. To address the above issues, we conducted this study to assess the safety and efficacy of Jain point in avoiding trocar injuries in patients with multiple previous surgeries.

Methods: We present a retrospective analysis of 720 cases with two or more previous surgeries conducted at a tertiary care referral centre for advanced gynecological laparoscopic surgery from January 2011 to July 2023. We perform a detailed preoperative workup of the patient and delve into all details of the previous surgeries including indications and nature of surgery, open or laparoscopic. We then inspect all scar sites to assess possible intra-abdominal adhesions and feasibility of Jain point entry. Veress entry is made at Jain point, which lies at L4 level on left side of abdomen, 10-13 cm lateral to the umbilicus. This is followed by primary blind trocar entry at the Jain point, which becomes the main working port in due course of the surgery. We make a note of intraoperative adhesions and postoperative complications.

Results: In total 720 cases with history of multiple previous surgeries, laparoscopic entry was safely made through Jain point port by consultants, senior residents and fellows, almost in equal number of cases. In this study group, no major bowel or vascular complications were noted.

Conclusion: Jain point laparoscopic entry is safe for all types of previous scars, in all quadrants of the abdomen, in all ranges of BMI, and age, with varied indications and by surgeons of various subspecialties. It is feasible in low resource settings as in this study we utilized our routine reusable trocars. Jain point has the potential to minimize trocar injuries in the hands of novice as well as experts, as its precise location avoids injury to vessels, viscera and bowel; thus posing as a safe and feasible laparoscopic entry port in multiple previous surgeries.

Introduction

Emergence of laparoscopy as a surgical technique began in the early 20th century, with key pioneers in the field, Georg Kelling and Hans Christian Jacobaeus¹. The transition from diagnostic to therapeutic laparoscopy occurred in the mid-20th century which brought about the need for instruments like trocars to assess the abdominal cavity safely. Laparoscopic surgery offers numerous benefits that have revolutionized patient care, enhanced surgical outcomes, and improved quality of life. Key-hole surgeries offer minimal scarring, reduced hemorrhage, enhanced visualization and magnification, reduced infection, shorter hospital stay, faster recovery, less postoperative pain, reduced chances of hernia and better cosmesis.

However, trocar injuries pose significant challenges, especially in patients with multiple previous surgeries, owing to altered anatomy, and visceral adhesions. This in turn can result in a range of complications, including vascular injuries, bowel perforation and damage to adjacent structures. Access-related vascular and gastrointestinal injuries are the leading cause of fatalities following laparoscopic surgery.² The overall reported rate of vascular injury (arterial or venous injury) ranges from 0.1 to 6.4 per 1000 laparoscopies³, out of which 50 to 83 percent occur during abdominal access.⁴ However, it is one of the most serious complications causing an immediate threat to the patient's life. Mortality after having a major vascular injury during laparoscopy has been reported between 6% and 13%.⁵ Injuries to the gastrointestinal tract occur in 0.03 to 0.65 percent of patients undergoing laparoscopic surgery. Forty-one to 50 percent of inadvertent bowel injuries occur during abdominal access⁶. These injuries not only lead to increased morbidity, prolonged hospitalization, and mortality but also pose substantial legal and ethical implications for the surgical team. Thus, finding effective methods to minimize trocar injuries is crucial, especially in patients with a complex surgical history, with multiple previous scars.

Entry devices have evolved over time to minimize the risk during primary trocar insertion. Earliest being sharp tip direct trocar entry, followed by veress needle, blunt tip trocars and Hasson open entry techniques⁷. Other novel devices such as the EndoTIP (Endoscopic Threaded Imaging

Port)⁸ and optical trocar systems⁹ were later attempted to minimize entry related injuries. Optical access devices (bladed or non-bladed) allow direct visualization of the anatomical layers as the abdominal wall is being traversed and offer more than just surgical tactile sensation. Other devices evaluated in experimental settings aside of live surgery include an ultrasonically activated trocar system¹⁰ and a dilating missile trocar which has not yet reached market¹¹.

Irrespective of the entry device used, there were issues with the entry point too. Umbilical entry was routinely used for laparoscopic access but in previous surgery cases, periumbilical adhesions and major retroperitoneal injury were reported. To mitigate the difficulties, other non umbilical ports were introduced. Palmer's point¹² was the most sorted after primary port in previous surgery cases but it could not avoid upper abdomen scars, hepatosplenomegaly, and upper abdomen masses.¹³ A few other ports like Lee Huang point¹⁴ and 9th intercostal space¹⁵ were also developed but ironically they were all in the upper quadrant of the abdomen, so the contraindications of Palmer's point persisted. To avoid the adhesions of upper abdomen and umbilicus, we used Jain point as the primary entry port, which lies in the mid-abdomen, 10- 13 cm lateral to the umbilicus.¹⁶ This research article aims to elucidate the efficacy and safety of Jain point entry technique in mitigating trocar injuries in patients with multiple previous surgeries. Although we have a large number of previous surgery cases entered through Jain point, this study will be limited to patients with two or more previous surgeries, to avoid over inflation of data. We present a retrospective analysis of patients with history of multiple previous surgeries, who underwent laparoscopic surgery at our tertiary care centre with the Jain point entry port in a span of 12 years.

Materials and methods

Since the early 2000, we started doing first blind port entry from the Jain point, and as we successively kept on using it, we found that this can also be used as the main working port throughout the surgery. So, we started using the Jain point as a primary port very routinely. As we were analysing the safety profile of Jain Point over the passing years, we realized this entry port could impact the safety of laparoscopic entry very positively. We were careful to jot down all

relevant information in an excel sheet from 2011 onwards and we have all relevant details including the patient's demographic profile, BMI, type and number of scars and indication of previous surgeries, emergency or planned and gynaecology or non-gynaecology. We also made a note of indication of present surgery, including complex surgeries, the degree of adhesions we encountered in our surgery, and the complications encountered during or after primary port insertion. We started publishing our data from 2014¹⁷ onwards and have been showcasing our technique of laparoscopic entry in live surgery workshops with general surgeons and gynecologists all over the world.

A retrospective analysis was conducted of all patients who underwent Gynae and general surgery laparoscopy cases at our centre between January 2011 and July 2023. The study protocol was approved by the institutional review board, and informed consent was obtained from all patients. All patients with a history of 2 or more previous surgeries were included in the study. Patients with history of previous one surgery or no surgery in the past were not tabulated to avoid data inflation.

Data were collected from Vardhman Trauma & Laparoscopy Centre Pvt. Ltd hospital's operation theatre records. To study the comprehensiveness of Jain point, all the data as previously mentioned was tabulated. Cases with multiple surgeries were counted only once when tabulating data for indication of surgery and type of incision to avoid over inflation of data. The data analysis was done using the Statistical Package for Social Sciences (SPSS version 21).

Preoperative planning is conducted with the surgical team and the surgeon identifies abdominal scars, potential adhesions, and areas of concern. Detailed history of the previous surgery is taken, and all old records are tabulated, asking whether the setting was emergency or routine, duration of hospitalization, any ICU admission, any drain inserted, resuturing done and any postop complications are all recorded. Often we contact the previous operating doctor to ask about the intraoperative adhesions. This is done in order to make an idea of the complexity of surgery, intraoperative adhesions and precise laparoscopic entry. The preoperative preparation comprises low residual diet for 48 h prior to

surgery and bowel preparation in all previous surgery cases. Patients are laid in lithotomy position and administered general anesthesia. After endotracheal intubation, the stomach is emptied of secretions and air by the use of orogastric tube by anesthetist. Intraoperatively, the surgeon carefully inspects all scars to assess the trocar placement site for any unexpected resistance or signs of adhesions, and evaluate the feasibility of Jain point entry. Adjustments are made as necessary to ensure safe entry. All 720 patients in our study were entered by Jain point as the primary entry port. In rare instances of scars or drain sites at Jain point, mirror Jain point on the right side was used for entry. Entry was made by senior consultant, junior consultants and many fellows and trainees over the study period. Our centre being a multispecialty hospital, multiple complex procedures having both Gynae and general surgery indications like cholecystectomy, appendectomy and hernia repair were all entered, by general surgeons and urologists through Jain point, which continued as the main working port throughout their surgery. Urologists and right handed surgeons preferred using right Jain point for entry and many a time used it also as a camera port.

To locate the Jain point, a horizontal line is drawn at the upper margin of the umbilicus. Then the ASIS, which is a prominent fixed bony landmark in the sterile surgical field, is marked and from 2.5 cm medial to the ASIS, a vertical line is drawn up to the level of the umbilicus. The point where the two lines meet is the "Jain point". (Fig.1A) In effect, the entry point lays approximately 10-13 cm lateral to the umbilicus, depending on the patient's body type, BMI, and central obesity. The operating table is laid in a horizontal position. A 1-2-mm nick is made just enough for the Veress needle's entry, which is entered perpendicular to the skin.(Fig.1B) Notably, the abdominal wall is not lifted, avoiding unequal forces being applied during entry and zigzag track, providing a precise appreciation of layer-by-layer entry. The same technique is applied for thin or obese patients. Two pops are clearly heard, the first when the needle passes through the aponeurosis of the external oblique muscle and the second when the needle passes through a fused aponeurosis of the transverse abdominal muscle and internal oblique muscle, after which the needle encounters loss of resistance as it enters the peritoneal cavity. Safety checks are done, the pneumoperitoneum is created, and the 5 mm

trocar and telescope are inserted at the Jain point. Endoscopic surgeons familiar with the technique of direct trocar entry have been using Jain point without prior Veress needle insertion.¹⁸



Fig.1A: Surface marking of Jain point in a patient with history of previous 3 laparotomies.

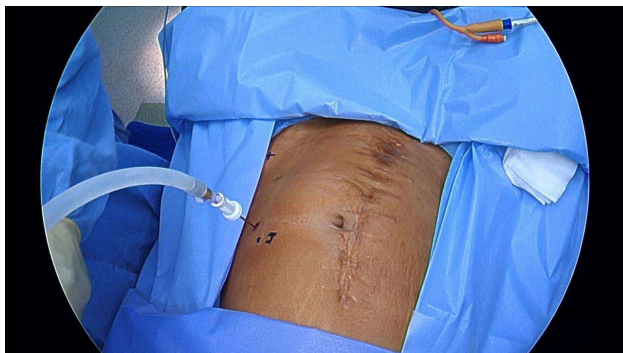


Fig.1B: Veress entry at Jain point

After entry, a 360° check of the abdominal cavity is done. A note is made of adhesions and their scoring and location, especially in the upper abdomen, to look for adhesions below Palmer's point and the right and left hypochondria to check for any sub-diaphragmatic adhesions. Then under vision, a supraumbilical 10 mm trocar and telescope is entered at an adhesion-free area according to the mandate of the surgery. After introducing the 10 mm port, safe abdominal entry of the 5 mm trocar through Jain point is also confirmed. Then lower right and left ports are inserted 2.5 cm medial and 1 cm above the ASIS, to avoid injury to nerves or blood vessels in the abdominal wall (notably the

ilioinguinal and iliohypogastric nerves, superficial and inferior epigastric arteries). The Jain point provides a working distance of 10-12 cm from the left lower port for good ergonomic working, becoming the main operating ipsilateral port throughout the surgery. (Fig.2) Operative time is calculated from the first incision to the completion of surgery. Complications directly related to the entry technique that occurred intraoperatively and were discovered either immediately or up to 2 weeks postoperatively, were recorded and were tabulated as minor and major complications.

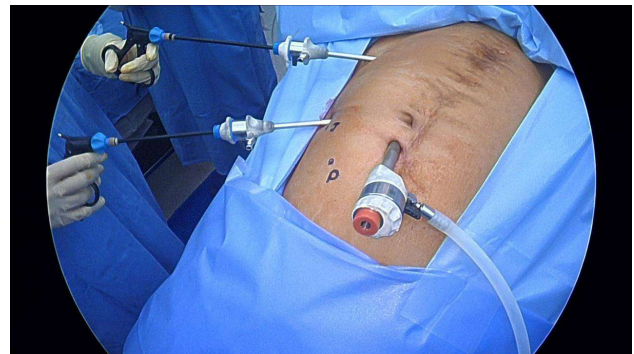


Fig.2: Jain point continues as the main ergonomic working port throughout the surgery.

Results

A total of 9549 patients underwent gynae laparoscopy surgery at our advanced laparoscopic center between January 2011 and July 2023. All cases were entered by Jain point as the primary port. Out of these, 2791 patients had a history of previous surgery and 720 out of these had previous 2 or more surgeries. Since this paper is restricted to previous 2 or more surgeries, results of Jain point entry in these 720 patients will be analyzed, to avoid over inflation of data. Laparoscopic entry was safely made through Jain point port by senior consultants, junior consultants, and fellows, almost in an equal number of cases. General surgeon colleagues and urologists also preferred entering at Jain point. The demographic profile of the patients, such as BMI, number of previous surgeries, and type of scars, is depicted in figures 3-5, respectively. The indication of previous surgeries, indication of present surgeries, and complex surgeries entered by Jain point is tabulated in Tables 1-3, respectively.

DISTRIBUTION OF CASES ACCORDING TO BMI (FIG.3)

This graph provides a comprehensive breakdown of the study population based on their Body Mass Index (BMI) categories. Out of 720 patients in our study, majority (40.69%) of our study participants fall into the overweight group with BMI ≥ 25 to <30 kg/m². 20.69% and 1.6 % patients in our study group were identified as obese and morbidly obese, respectively. While 2% participants in our study group were found to be underweight with BMI <18.5 kg/m². Apart from above discussion, a significant proportion (34.86%) belong to the healthy weight group with BMI ≥ 18.5 to <25 kg/m². This graph shows the effectiveness of Jain point entry technique in all ranges of BMI, as no major complication was reported, irrespective of weight status.

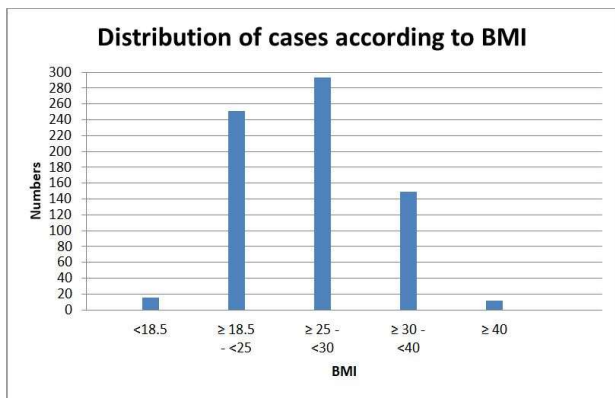


Fig.3: Distribution of previous surgery cases according to BMI

DISTRIBUTION OF CASES ACCORDING TO NUMBER OF SURGERIES IN THE PAST (FIG.4)

This graph depicts the distribution of our study population based on the number of previous surgeries they have undergone. This information is critical for understanding the surgical history and complexity of the patients included in our analysis. Among the study participants, majority (74.58%) have a history of two previous surgeries. Within this category, 449 patients underwent previous laparotomies; while 88 patients had previous laparoscopies. A significant portion of our study population (20.14%) had a history of three previous surgeries. This group includes 137 individuals with previous laparotomies and 8 individuals with previous laparoscopies. Many patients had both laparotomy and laparoscopy scars. Since we have analyzed the scar type, laparotomy incision was counted instead of laparoscopy, as laparotomy has more propensities for adhesion

formation, thereby increasing the chances of trocar injury. A smaller subset of our study participants (3.9%) had a history of four previous surgeries. Within this category, 27 patients underwent previous laparotomies, and 1 patient had a previous laparoscopy. We also had 10 cases with a history of five or more previous surgeries with laparotomy scars.

This graph illustrates the number and type of previous surgeries our participants have undergone, making them prone for adhesions and altered anatomy, thereby increasing the potential challenges and risks associated with trocar injuries. In our study population, no trocar injury was reported despite having patients with varying surgical backgrounds.

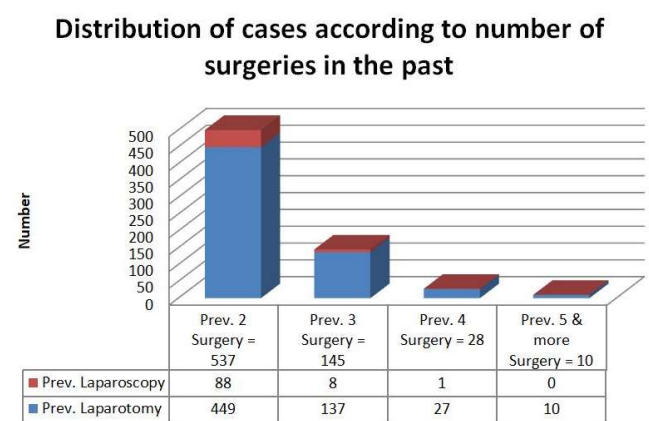


Fig.4: Distribution of cases according to number of surgeries in the past

DISTRIBUTION OF CASES ACCORDING TO THE TYPE OF SCAR OF PREVIOUS SURGERY (FIG.5)

Graph 3 provides a comprehensive overview of the distribution of patients in our study based on the type of scar resulting from their previous surgeries. This information is crucial for understanding the diversity of surgical histories within our study population. A significant proportion of our patients, 54.58% of cases, have transverse scars from previous surgeries in the upper abdomen, mid-abdomen, and lower abdomen. We identified 25.83% cases where patients had vertical scars from their previous surgeries, with a few patients having non classical incisions such as previous drain sites, colostomy sites, incisions for renal surgeries, and long vertical incisions extending from the epigastrium up to the pubic symphysis in prior surgery for intestinal obstruction, burst abdomen, septicemia, and other complex pathologies. We also had patients with atypical abdominal scar

marks, with Hirschsprung's disease in the early neonatal period. Mc Burney's scar was observed in 19 cases while Kocher's scar was noted in 24 cases. A noteworthy number of patients, amounting to 97 cases, had laparoscopic scars from previous minimally invasive procedures, located at various sites on the abdomen, depending on the specific laparoscopic procedure. 1 case in our study population had Chevron scar.

This graph depicts the variety of scars from previous surgeries in our study population. Jain point lying in a nascent zone, free of viscera and thus surgical scars, was equally applicable in all type of scars, lying in all quadrants of the abdomen. No trocar injury was reported in any patient irrespective of previous scar sites.

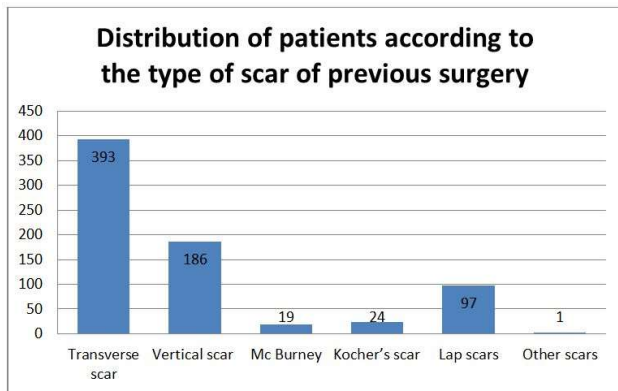


Fig.5: Distribution of patients according to the type of scar of previous surgery

TABLE 1A: DISTRIBUTION OF CASES ACCORDING TO THE TYPE AND INDICATION OF PREVIOUS GYNAE SURGERY

Out of 720 cases in our study, 611 had previous surgery for Gynae indication and 109 cases were previously operated for general surgery indication. Table 1a offers a detailed breakdown of the patient's profile based on the surgical history of our study population and the specific indications that led to their previous gynecological procedures (611). The two subcategories within this column represent cases that had laparotomy (547 cases) and laparoscopy (64 cases) as the previous surgical approach. The majority of previous Gynae surgeries (74.63%) involved LSCS. For patients with a history of ectopic pregnancy, 28 cases were treated with laparotomy, while 10 cases underwent laparoscopy. In cases diagnosed with endometriosis, 6 were treated with laparotomy,

and 17 with laparoscopy. For myomectomy, 18 cases had laparotomy, and 6 cases had laparoscopy. Hysterectomy was performed in 9 cases through laparotomy and in 3 cases through laparoscopy. Among cases involving infectious pathologies like genitourinary tuberculosis, 4 underwent laparotomy, while 11 underwent laparoscopy. For patients with previous tubo-ovarian mass, 7 cases were treated with laparotomy and 4 cases treated with laparoscopy. For ovarian cyst cases, 11 underwent laparotomy, and 2 underwent laparoscopy. One case with Mullerian anomaly had laparoscopy as the previous surgery type. In cases of infertility workup, 2 had laparotomy, and 6 had laparoscopy. Three cases underwent laparotomy for ligation. In patients with pelvic floor repair and tubo tubal reanastomosis, 3 cases were treated with laparotomy and 4 cases treated with laparoscopy. We encountered a patient with history of previous 3 laparotomies done for ruptured appendix, ovarian cyst and inclusion cyst. Now she came to us for infertility evaluation and ovarian cystectomy. We found bowel loops stuck all over the abdomen, contraindicating other entry ports. (Fig.6A) Jain point was found to be free, even in such complex scenario. (Fig.6B) Thus, our subjects had been previously operated for a variety of Gynae indications. This is essential for assessing the potential impact of these factors on the risk of trocar injuries.

Previous Gynae Surgery (n=611)		
Indications of surgery	Laparotomy (547)	Laparoscopy (64)
Lower segment caesarean section (LSCS)	456	0
Ectopic pregnancy	28	10
Endometriosis	6	17
Myomectomy	18	6
Hysterectomy	9	3
Infectious pathologies	4	11
T.O. mass / Abscess	7	4
Ovarian cyst	11	2
Mullerian anomalies	0	1
Infertility workup	2	6
Ligation	3	0
Others, including Pelvic floor repair and Tubo tubal reanastomosis	3	4

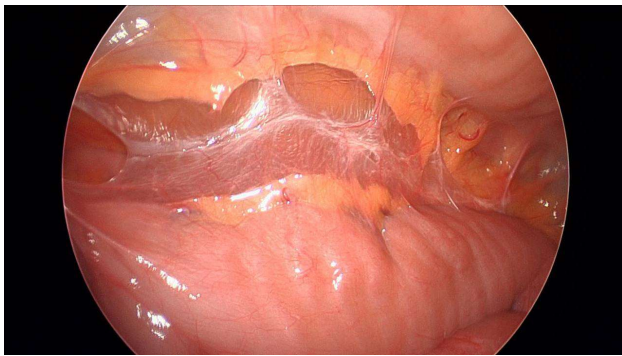


Fig.6A: Laparoscopic picture of the same patient showing bowel loops stuck all over the abdomen.

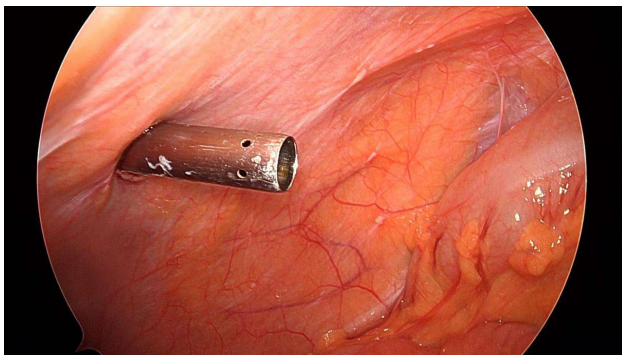


Fig.6B: Jain Point free of any adhesions, even in case of multiple previous surgeries with dense bowel adhesions all over the abdomen.

TABLE 1B: DISTRIBUTION OF CASES ACCORDING TO THE TYPE AND INDICATION OF PREVIOUS GENERAL SURGERY

Table 1B provides a comprehensive breakdown of the study population based on the type of previous abdominal general surgeries they have undergone. Out of 109 patients in this study group, majority had undergone cholecystectomy as previous surgery, 23 by laparotomy and 11 by laparoscopy. Among cases of previous appendectomy, 22 operated by laparotomy and 8 by laparoscopy. Among cases involving ventral hernia mesh repair, 11 had laparotomy as the surgical approach, and 5 had laparoscopy. 13 cases with a history of intestinal obstruction and 8 of intestinal perforation were treated with laparotomy. 5 cases of renal surgery involved laparoscopy as the surgical approach. One case of septicaemia and 2 of Hirschsprung's disease were treated with laparotomy.

Previous Abdominal General surgery (109)		
Indication of surgery	Laparotomy (80)	Laparoscopy (29)
Appendectomy	22	8
Cholecystectomy	23	11
Renal surgery	0	5
Intestinal obstruction	13	0
Intestinal perforation	8	0
Ventral hernia mesh repair	11	5
Septicaemia	1	0
Hirschsprung's disease	2	0

TABLE 2: DISTRIBUTION OF CASES ACCORDING TO THE INDICATION OF PRESENT LAPAROSCOPIC SURGERY USING JAIN POINT

This table provides a comprehensive breakdown of the study population based on the specific indication of present laparoscopic surgeries conducted using the Jain Point technique, in patients with history of multiple previous surgeries. The most frequently performed procedure in our study was Total Laparoscopic Hysterectomy, with 281 surgeries, highlighting its importance in gynecological surgery. A significant number of surgeries (114) were performed for infectious pathologies, underscoring the importance of Jain point entry in managing such conditions. This was followed by 92, 79, and 54 cases done for infertility, endometriosis, and myoma, respectively. Our study included 41 surgeries for ectopic pregnancies, a critical and potentially life-threatening condition. There were 30, 11, 9 and 7 surgeries done for ovarian cysts, pelvic organ prolapse, mullerian anomalies, and adenomyoma, respectively. The variety and frequency of procedures addressed through Jain point entry technique, highlights its versatility and applicability across various gynecological contexts. Many complex surgeries were performed for both Gynae and general surgery indications. All were entered with Jain point and have been tabulated in the next table.

Present procedure name	Number of surgery
TLH	281
Adenomyomectomy	7
Myomectomy	54
Endometriosis	79
Ovarian cyst	30
Infectious pathologies	114
Ectopic	41
Pelvic floor repair	11
Mullerian anomalies	9
Diagnostic Laparoscopy & Hysteroscopy	92

TABLE 3: DISTRIBUTION OF CASES ACCORDING TO MULTIDISCIPLINARY PREVIOUS SURGERY CASES ENTERED USING JAIN POINT

Post-COVID to sustain the hospital, we started regular general surgery and urology department at our center. Since then, the number of cases involving these surgeons has been on a steady rise. And since general surgeons have now got familiarized with Jain point; they have been using it frequently as the modality of entry. Table 3 offers a comprehensive breakdown of complex entry procedures involving both gynecologists and general surgeons, performed in cases with a history of multiple previous surgeries. These cases with co-occurrence of Gynae and general surgery problems necessitated precise entry techniques, and the table presents various types of surgeries, the number of cases for each procedure, and the consistent use of the Jain Point entry technique. Although these cases are vast in number, in this paper we are restricted to discussing only those patients with a history of previous two or more surgeries, to avoid overinflation of data. 37 appendectomy and 48 cholecystectomy cases were performed by surgeons along with Gynae surgeries. (Fig.7A) We involved urologists in 9 cases with 4, 3, and 2 cases of Burch colposuspension, uretero ureteric re-implantation, and VVF repair, respectively. Nineteen cases involved total laparoscopic hysterectomy (TLH) along with ventral hernia repair by surgeons. (Fig.7B) In four cases, patients underwent rectopexy to address rectal prolapse concurrently with surgical management for genital prolapse. Four cases involved gynecological procedures alongside the treatment of incidentally diagnosed mesenteric cyst. In three cases, patients with gunshot wounds underwent gynecological surgery, illustrating the complexity of addressing traumatic injuries alongside gynecological procedures. One case involved gynecological

surgery in conjunction with Nissen fundoplication, to treat achalasia cardia. Three cases required gynecological surgery in the context of a previous history of radiation therapy, chemotherapy, or prior oncology procedure, illustrating the complexities of laparoscopic entry post adhesions and fibrosis. Four cases involved laparoscopic cystectomy procedures performed during pregnancy, highlighting the need for careful entry in pregnant patients. All patients were entered by Jain point which continued as the main working port throughout the surgery. For right-handed surgeons and urologists, entry was made through a mirror image of Jain point from the right side. The consistent use of the Jain Point entry technique in these cases underscores its adaptability and effectiveness in ensuring safe entry during complex multidisciplinary procedures.

Type of Surgery	Number of cases	Surgical Techniques
Laparoscopic Gynae surgery + Appendectomy	37	Jain Point entry
Laparoscopic Gynae surgery + Cholecystectomy	48	Jain Point entry
Laparoscopic Gynae surgery with urological surgery		
1. Burch colposuspension	4	Jain Point entry
2. Uretero ureteric re-implantation	3	
3. VVF repair	2	
TLH with Ventral Hernia repair	19	Jain Point entry
Rectopexy with genital prolapse	4	Jain Point entry
Gynae procedures with Mesenteric cyst	4	Jain Point entry
Gynae surgery in patients with Gunshot wounds	3	Jain Point entry
Gynae surgery with Nissen Fundoplication	1	Jain Point entry
Gynae surgery in prev. history of Radiation/ Chemotherapy/ Prev. Oncology Procedure	3	Jain Point entry
Laparoscopic cystectomy in pregnancy	4	Jain Point entry

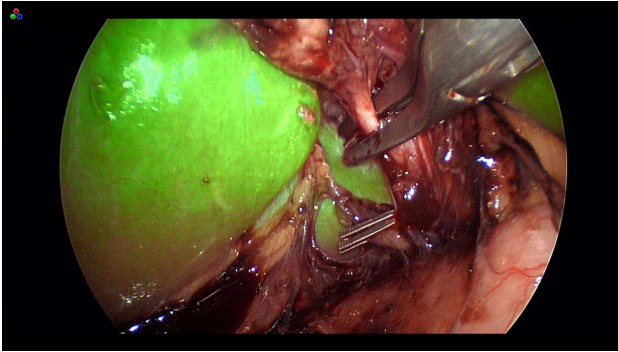


Fig.7A: Laparoscopic picture showing complex multidisciplinary cases done using Jain point as the main ergonomic working port. (Laparoscopic cholecystectomy)

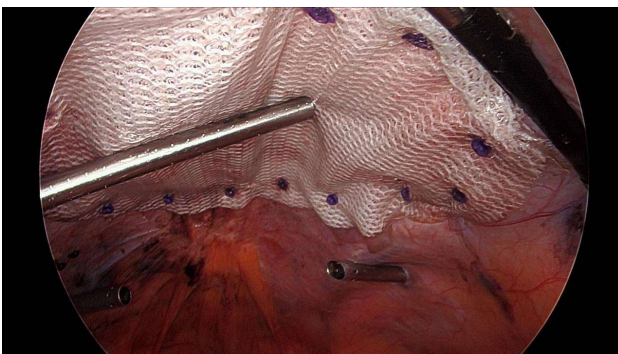


Fig.7B: Laparoscopic ventral hernia mesh repair using absorbable tackers.

Our findings reveal that no significant entry-related vascular injury was encountered with the use of Jain Point as the primary port for laparoscopic procedures. This is attributed to the precise location of Jain point lying far lateral in the mid-abdomen away from both major retroperitoneal vessels and minor epigastric vessels. No visceral injury was reported in our study, probably due to the location of Jain point in a nascent zone, as stomach spleen and kidney lie higher up at T10-L1 level and sigmoid physiologically adheres at pelvic brim. This gives a large area in the left side of the abdomen, free from any viscera and thereby adhesions. Also, the stomach is routinely emptied of secretions by our anesthetist, after endotracheal intubation, further decreasing the chances of injury to bloated stomach. In 2 morbidly obese patients, entry through Jain point could not be made as it showed high initial verres pressure, so we had to do verres needle entry from the umbilicus and create pneumo peritoneum and then make 5 mm blind trocar entry at Jain point. Minor complications were encountered with multiple previous surgeries, in 2.7% cases. We noted omental emphysema in few thin patients, due to

the occasional overshoot of the verres needle which was quickly detected by higher intra-abdominal pressure in the first 10 seconds. We also reported preperitoneal insufflation in a few cases in the initial learning phase. These minor complications keep improving as the learning curve stabilizes as we have almost one third entry made by fellows and trainees. However, they resolved on their own and did not alter the course of surgery. In the duration of 12 years, many patients operated previously through Jain point are coming back to us for repeat surgery like previously operated for severe endometriosis now coming for total laparoscopic hysterectomy. In these patients, we observed that in 97 % cases, no adhesion was noted at Jain point. In rest 3 % cases, streaks of omental adhesions were noted, which did not incite any bleeding or need suture ligation. Additionally, no surgeries required conversion to laparotomy. No morbidity or mortality was reported with the use of Jain point as the primary port. Furthermore, no cases of hematoma formation post-surgery were noted. Additionally, there was no occurrence of incisional hernia at the Jain Point site during long-term follow-up, indicating the absence of postoperative complications in this regard.

Discussion

Trocar injuries during laparoscopy pose a serious concern, particularly in patients with a history of multiple previous surgeries, owing to complex abdominal anatomy and underlying adhesions. This can lead to severe complications, including vascular damage, visceral injuries, and increased morbidity, posing substantial challenges to surgeons. In response to this critical issue, our study introduces the Jain Point technique, a novel approach specifically designed to mitigate these challenges and minimize the occurrence of trocar injuries in this high-risk patient population with history of 2 or more previous surgeries.

The core principle of the Jain Point technique lies in its precise anatomical selection. The rationale behind using Jain point is that the viscera on the left side that is spleen, kidney and bloated stomach lie higher up at T10-L1 level, while sigmoid is physiologically adherent at the pelvic brim, leaving a large nascent area on the left side. Located at L4 level, approximately 10-13 cm lateral to the umbilicus, the Jain Point is strategically chosen to avoid vital structures,

adhesions, and bowel.¹⁹ This lateralized entry point steers clear of common pitfalls associated with traditional entry sites like the umbilicus, Palmer's Point, and others. In particular, it reduces the risk of inadvertent injuries during trocar insertion by avoiding areas of scarring and adherent tissues. Additionally, the Jain Point's strategic positioning helps avert the concern of injury to major retroperitoneal vessels, a significant consideration during umbilical entry.²⁰ Notably, the superior and superficial epigastric vessels, which often lie within 5 cm of the midline, are also avoided with Jain point entry.

Umbilical access is most commonly used by surgeons of varied specialties but can lead to complications in patients with history of multiple previous surgeries causing periumbilical adhesions, in patients with periumbilical mesh, umbilical or ventral hernia, large pelvic mass, and pregnancy. In a systematic review, the estimated risks for umbilical and/or anterior abdominal wall adhesions were 0 to 5 percent for women with no prior surgery, 20 to 30 percent for those with a previous transverse suprapubic laparotomy, and 50 to 65 percent for those with a previous midline laparotomy.²¹ Non-umbilical access may be preferred under these circumstances.²² This is consistent with the findings in our study, which show Jain point's feasibility in multiple previous surgeries, previous ventral hernia mesh repair, large pelvic masses and pregnancy.

Palmer's point has been relied on for years in patients with history of previous surgeries. But as the number of previous surgeries and complexity of surgical indications have increased, various contraindications of Palmer's point have emerged like upper abdominal scar on left side due to previous gastric or splenic surgery; large masses in upper abdomen, hepatosplenomegaly, and gastro pancreatic masses.²³ Palmer's point entry may lead to injury to bloated stomach, which remains highly unreported. Another entry port, Lee Huang point[14] was developed with the benefits of higher location and central vision and a wider working space. Although this point was extensively used in patients with previous surgeries, it was not free from complications. In a series of 188 cases, 2 omental injuries from primary port insertion and 1 colon injury were reported. Left 9th intercostal space[15] in the anterior axillary line at the superior surface of lower rib was also used for Veress needle

insertion. It had a failure rate of 0.39%, and the risk of splenic injury and bleeding from subcostal artery limited its use²⁴. These entry ports have advantages of their own; but being in upper abdomen, they share the same contraindications as Palmer's point.²⁵

In a remarkable case, we encountered a patient with a significant upper abdominal laparotomy scar, resembling a chevron incision scar. Traditional entry through Palmer's point was deemed contraindicated due to the challenging nature of this scar. In this scenario, we successfully employed the Jain Point technique for trocar insertion.²⁶ In a separate study by Sharma et.al., the bowel was found stuck completely over Palmer's point in several patients with previous infectious pathologies²⁷, almost making a second layer of the peritoneum. In another study involving 106 patients with upper abdominal scars or extension of long vertical scars, we consistently used the Jain Point technique for laparoscopic entry.²⁸ There were no other major complications noted, except one injury in a patient with previous one surgery for childhood Koch's, with transverse scar at level of umbilicus. This complication was recognized immediately, the bowel loop was extracted by widening the port, and the bowel was sutured and repositioned back. The patient did well postoperatively and was discharged in 3 days. This comprehensive cohort demonstrates the practical applicability of the Jain Point across a range of cases, including those with diverse upper abdominal scars. Harry Reich, in his foreword for the book, "Non-Umbilical Laparoscopic Entry Ports", published in the year 2020²⁹, mentions that the Jain point with a prominent bony landmark, ASIS, is the lowest of all entry ports and may be best for routine use. Moreover, Palmer's point becomes redundant after entry while Jain point situated left laterally in mid abdomen, continues as the main ergonomic working port for both upper and lower abdomen³⁰.

To prevent accidents due to the trocars, some authors (Hasson, 1971) have suggested performing an open laparoscopy.[7] This technique may indeed reduce the risk of major vascular injuries but does not prevent the risk of bowel injury; especially in case of type 2 bowel adhesions where bowel is stuck up like the second layer of abdominal wall. This type of injury would be unavoidable by any other entry

method, except placing the trocar in a location where bowel adhesions will not be present. On this account, Jain points scores over the Hasson technique and other entry ports. A meta-analysis of 5,284 patients undergoing operative laparoscopy through the Hasson open entry technique reported primary access complications including 1 bowel injury, 21 wound infections, 4 minor hematomas, and 1 umbilical hernia.³¹ Other reasons for limiting the use of open technique include greater time needed for performance, difficulty with the technique, cumbersome in obese patients, and difficulty in maintenance of the pneumoperitoneum.

Moreover, our study suggests that Jain Point entry was found to be feasible in all cases, irrespective of BMI.³² This improvement in efficiency may be attributed to the precise anatomical location of the Jain point; free of any vessel, viscera, adhesion, and bowel. Also, careful preoperative planning, which includes a meticulous assessment of the patient's previous scars and suspected adhesions, allows for precise trocar placement. In contrast, in patients with low BMI; umbilical entry and Palmer's point pose a risk of laparoscopic access, owing to being in close proximity to major retroperitoneal vessels, and the left kidney, respectively. Similarly, umbilical entry and Hasson open entry technique is difficult in obese patients³³.

Thus, the Jain Point technique introduced in this study offers a valuable alternative that addresses the limitations associated with Palmer's point³⁴ and other upper abdominal entry sites. Our findings demonstrate that the Jain Point, situated in the mid-abdomen but positioned laterally, is equally applicable for all type of scars, regardless of their location within the abdomen (upper, mid, or lower).[16] Importantly, we observed no adhesions below the Jain Point, even in cases with complex surgical histories and diverse indications.

Jain points entry is easily reproducible as is evidenced by successful entry made in almost equal number of cases by senior gynecologists, junior consultants, various fellows and trainees over a span of 12 years. This is probably attributed to the ease of locating it by a single prominent bony landmark, the ASIS, and a well-defined technique. Also, laparoscopic general surgeons and urologists have made entry

through Jain Point in complex multidisciplinary cases.^{35,36} Moreover, they continued using Jain point port as the main working port throughout the course of surgery. This is supported by the fact that Jain point lies in mid abdomen, so they could reach both the depth of pelvis and upper abdomen with equal ease. The Jain point is, at times, used by them as a camera port as in cholecystectomy, appendectomy, and evaluation of patients with pain in the abdomen and hernia repairs. It can be a valuable entry point in bariatric surgery as the study indicates Jain point's safety in high BMI patients and can be later used for stomach retraction. Our study also demonstrates the safety of Jain point entry in patients with previous chemotherapy, radiotherapy and prior oncological procedures. Oncosurgeons, while using it in a primary procedure or with second-look procedures after neoadjuvant chemotherapy, have found it safe in the context setting of advanced adhesion scores in such indications³⁷. A recent publication, from urologists and cardiothoracic surgeons of China, has also sited Jain point as the primary entry port.³⁸

Another noteworthy outcome of our study is the lower rate of postoperative complications observed with the Jain Point entry. We have been routinely using the 5 mm reusable pyramidal tip metal trocar for entry at Jain point, and our finding suggests that the Jain Point entry port avoids trocar injuries. This can be a grinding force for low economic settings, as no need of using the costly optiview trocar systems, safety shield, threaded trocars, and any specific trocar designed to avoid trocar injuries. Our philosophy is to move to an area where adhesions are not expected, so irrespective of the trocar design, we have been avoiding trocar injuries by using the Jain point as the primary port, even in the face of multiple previous surgeries and suspected adhesions.

The Jain Point technique, as introduced and explored in our study, has garnered attention from researchers and laparoscopic surgeons in various publications. These references highlight the distinct advantages and benefits of the Jain Point technique, particularly in cases involving previous surgeries and complex anatomical considerations. Wasson and colleagues recommend the use of Jain Point technique, particularly in patients where adhesive disease is suspected. This endorsement underscores the

utility of Jain Point in navigating potential adhesions and enhancing the safety of laparoscopic entry.³⁹ Bedaiwy and associates have documented the advantages of Jain Point technique, especially in cases where periumbilical adhesions are anticipated.⁴⁰ Their findings support the use of Jain Point as a means to facilitate safe subsequent 10 mm supra-umbilical port entry. Reynolds, in his thesis, highlights the Jain Point as a proposed alternate entry site when first three options, namely the umbilicus, Palmer's point, and Lee-Huang point, are not suitable. This recognition underscores Jain Point's versatility in challenging scenarios.⁴¹ In a recent textbook on Minimally Invasive Gynecology, Einarsson et al. describe the Jain Point as a valuable alternative to Palmer's point.⁴² Positioned on the left side of mid-abdomen, 2.5 cm medial to the anterior superior iliac spine (ASIS), the Jain Point offers a reliable entry site. Eamudomkarn and colleagues, in a recent publication, emphasize the benefits of the Jain Point over other entry points. Positioned lower and more laterally than Palmer's and Lee-Huang points, the Jain Point minimizes the risk of injury to visceral structures.⁴³ Salcedo and their team describe the successful use of the Jain Point in laparoscopy during pregnancy. This aligns with our own observations, where we have used Jain point in pregnant patients with history of multiple previous surgeries. The lateral positioning of the Jain Point offers ample space for the gravid uterus, contributing to its safety and feasibility in pregnancy.⁴⁴

It is worth noting that while many publications have acknowledged the utility of Jain Point, some references have inaccurately depicted its location. For instance, "Clinical Perspective Concerning Abdominal Entry Techniques" by Recknagel et al.⁴⁵ and "Abdominal entry in laparoscopic surgery" by Pepin⁴⁶ have incorrectly portrayed the Jain Point as being "directly lateral to the umbilicus, and 2.5 cm medial to a line drawn vertically upwards from the left ASIS." Such discrepancies highlight the importance of precise anatomical understanding and accurate depiction when referencing the Jain Point technique in medical literature.

Our study presents promising results, supported by a robust dataset of close to 10000 cases that includes a substantial number of patients with multiple previous surgeries and complex multispecialty cases done over a span of 12

years. The strength of our study lies in its ability to shed light on the efficacy and safety of the Jain Point technique in avoiding trocar injuries, even in challenging scenarios. The only drawback is its retrospective design.

Conclusion

In scenarios where there are crisscrossing abdominal scars leaving surgeons pondering about their primary access point, the Jain Point technique emerges as a robust solution. This study, encompassing diverse patient demographics, history of multiple surgeries, multitude of scars spanning all quadrants of abdomen, performed by surgeons of various subspecialties and different expertise level; demonstrates the utility of the Jain Point entry technique in reducing trocar injuries. Due to its precise location, it avoids injury to major retroperitoneal vessels, superficial epigastric vessels, viscera and bowel. It is feasible in low resource settings with the usage of the routine reusable trocars. Moreover, it continues as the main ergonomic working port throughout the surgery, posing as a safe and feasible laparoscopic entry port in multiple previous surgeries.

Conflict of interest statement

Dr. Nutan Jain, Dr. Sakshi Srivastava, Dr. Suksham Sharma and Dr. Vandana Jain declare that there is no conflict of interest.

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