ORIGINAL RESEARCH ARTICLE

# Comparison of duration of Laparoscopy Procedure and Intraoperative Complications in Three Ports Versus Four Ports Laparoscopic Cholecystectomy- An Observational Study

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**A B S T R A C T**

**Introduction:** Laparoscopic Cholecystectomy (LC) is one of the most performed abdominal surgical operations. Therefore, we conducted a prospective observational study to compare three-port and four-port laparoscopic cholecystectomy at our tertiary care centre.

**Material and Methods:** The present study was conducted among 60 patients of gallbladder pathology. The exposure group comprised of participants with gallbladder pathology who were operated on following the 3- port LC technique and the control group comprised of participants with gallbladder pathology who were operated using the 4-port technique. The primary outcome was the conversion to open cholecystectomy surgeryin the two study groups. We aimed to assess whether data supplied evidence of the superiority of 3-port LC for the primary outcome. Categorical variables were analysed using chi-square ($\chi^2$) tests. A *P*-value < 0.05 was considered statistically significant.

**Results:** Overall, for various reasons, about 8.3% of participants needed conversion to open cholecystectomy: 7.4% and 9.1% of participants in the 3-port and 4-port groups needed conversion to open cholecystectomy, respectively. There was no statistically significant difference between the two study groups regarding the conversion to open cholecystectomy. About 7.4% of participants in the 3-port group required an additional port for completing the surgery. For most participants in both group 3-port and 4-port, the surgical procedure was completed within one hour. The mean duration of laparoscopy among the participants in the 3-port and the 4-port group was 67 and 68.5 minutes, respectively, and this difference was not significant (p=0.8508).

**Conclusion:** In conclusion, the 3-port technique is a safer alternative to the standard 4-port technique that offer many advantages with no increase or additional complications in the hands of an experienced surgeon. However, under any condition, if the need arise the surgeon should not hesitate toconvert a 3-port technique to a 4-port technique or convert a laparoscopicprocedure into an open cholecystectomy. Any conversion or change in theprocedure should not be seen as a failure of the method, rather as a judgement ofthe surgeon to prioritize the life of the patient.

**Keywords:** Gallbladder Pathology; Laparoscopic Cholecystectomy (LC); 3 Port; 4 Port LC

## INTRODUCTION

Worldwide, Laparoscopic Cholecystectomy (LC) is one of the most performed abdominal surgical operations. Traditionally, laparoscopic cholecystectomy has been performed through four ports (two 10 mm and two 5 mm ports).[1] Though four-port laparoscopic cholecystectomy is an acceptable gold standard for gallstone diseases, a lot of modifications of this technique are happening ever since the first case of LC was performed in 1989. Over the last three decades, several surgeons had tried to modify the LC procedure as per their needs and skills.[2] Some had experimented with the number of ports while others have experimented with the size of ports. The value of the lateral (fourth) port in the standard LC technique (to hold the gall bladder fundus) has been challenged by many surgeons.[3-5] Several members of renowned surgical societies believe that reducing the number, or the size of ports did not affect the safety of the procedure, rather enhanced the advantages of laparoscopic over open cholecystectomy. The technique of LC is constantly evolving under pressure from rapid change in the available technology to make it safer, less painful, more cosmetic, and further cost-effective.[6] Several studies have consistently shown that the reduction in either the number or the size of the ports is associated with reduced recruitment of pain medications. The three-port technique is technically feasible, safe, has cosmetic and cost advantages over the four-port technique.[7] Therefore, we conducted a prospective observational study to compare the safety and outcome, between three-port and four-port laparoscopic cholecystectomy at our tertiary care



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centre by enrolling a total of 60 participants.

## MATERIAL AND METHODS

The present prospective observational study was conducted at L N Medical College & Research Centre and affiliated J K Hospital, Bhopal, Madhya Pradesh among 60 patients of gallbladder pathology. The exposure group comprised of participants with gallbladder pathology who were operated on following the 3- port LC technique and the control group comprised of participants with gallbladder pathology who were operated using the 4-port technique.

The study was commenced after approval from ethical committee. Inclusion Criteria consisted patients with uncomplicated symptomatic gall stone disease, the patient presented within 72 hours of development of acute cholecystitis, patients who opted/agreed for laparoscopic cholecystectomy, patients between 18-70 years of age, patients of all genders and patients who gave written informed consent to take part in the study. Exclusion criteria comprised of patients with acute cholecystitis for more than 72 hours, patient aged either <18 or > 70 years, patients with impaired liver function test, patients with any of the following GB pathology (such as suspected GB malignancy, empyema, perforation, or choledocholithiasis), uncontrolled portal hypertension, deranged coagulation profile, patients unfit for general anesthesia and patient's refusal to take part in the study.

A patient opting for laparoscopic cholecystectomy for GB disease under general anesthesia and fulfilling the above-mentioned selection criteria. The questionnaire was approved by the ethical committee before starting data collection.

For pre-operative preparation, the surgical team conducted a detailed history and a thorough general examination of every participant. Thereafter, appropriate laboratory and radiological investigations were conducted. One day before the scheduled surgery, the anaesthesiologist's team completed a detailed pre- anaesthetic evaluation.

All patients were kept on nil-per-oral one night before the surgery and were given tablet Pantoprazole 40 mg as premedication. On arrival in the operating room, the identity of the participant and the consent was verified again; the preoperative assessment was reviewed and updated. The anaesthesiologist verified the nil-by-mouth status.

The operating team attached various monitors to measure the multiple vital parameters viz. pulse rate, non-invasive blood pressure, pulse oximetry, cardiac rhythm, and body temperature during the peri-operative period. Thereafter, pre- induction vital readings were noted. A prophylactic dose of antibiotic was given just before induction. The patients of both groups were given general anaesthesia following the standard protocol for laparoscopic cholecystectomy.

All patients were placed in reverse trendelenburg position with the table tilted downward to the patient's left to bring the operative field toward the surgeon and displace intra-abdominal organs away from the gallbladder. In both groups, carbon dioxide was used to create pneumoperitoneum during laparoscopy. The intra-abdominal pressure was maintained at 12-14 mmHg.

The vital parameters were recorded at the prescribed time points during the perioperative period. The time needed for extubation in the two groups were noted. Total time for the surgery was noted.

The primary outcome was the conversion to open cholecystectomy surgery (safety & feasibility) in the two study groups. We aimed to assess whether data supplied evidence of the superiority of 3-port LC for the primary outcome.

Categorical variables were analysed using chi-square ($\chi^2$) tests. A *P*-value < 0.05 was considered statistically significant.

## RESULTS

Table 1 illustrates the age group-wise distribution of the participants who underwent 3-and 4- Port Laparoscopic Cholecystectomy. Overall, about 23% of participants each were in their 5th and 6th decade of life while only 15% of participants were aged between 18-33 years. Further, the mean and median age of participants was in the present study was 48.6 and 48.5 years, respectively.

The mean age of the participants in the 3-port and 4-port groups was 51.4 years and

45.3 years, respectively. However, the difference in the mean age of the participantsin the 3-port and the 4-port group was statistically nonsignificant (p= 0.0749). The median age of the participants in the 3-port and 4-port groups was 50 years and 45 years, respectively.

Overall, there were approximately more than twice as many female (68.3%) participants in comparison to male participants (31.7%). In the 3-port group: females and males were 62.9% and 37.1%, respectively whereas in the 4-port group female and males were 72.7% and 27.3% respectively. There was no statistically significant difference between the two study groups in terms of gender distribution (p = 0.419). Table 2 shows the gender-wise distribution of study participants in the two study group.

Overall, for various reasons, about 8.3% of participants needed conversion to open cholecystectomy for completion of the procedure. Further, 7.4% and 9.1% of participants in

| Age | | | |
|---|---|---|---|
| | 3P (n, %) | 4P (n, %) | Total (n, %) |
| 18-30 | 1 | 8 | 9 |
| | 3.70 | 24.24 | 15.00 |
| 31-40 | 4 | 7 | 11 |
| | 14.81 | 21.21 | 18.33 |
| 41-50 | 9 | 5 | 14 |
| | 33.33 | 15.15 | 23.33 |
| 51-60 | 6 | 8 | 14 |
| | 22.22 | 24.24 | 23.33 |
| >60 | 7 | 5 | 12 |
| | 25.93 | 15.15 | 20.00 |
| Total | 27 | 33 | 60 |
| Mean (SD) | 51.4 (11.78) | 45.4 (14.88) | |
| Median (IQR) | 50(44-61) | 45(33-58) | |
| Range | 23-70 | 22-70 | P= 0.0749 |
| SD- Standard Deviation IQR- Inter Quartile Range | | | |

**Table-1:** Age distribution of participants (n = 60)

| Gender | | | | Chi- squaretest | Value |
|---|---|---|---|---|---|
| | 3P (n, %) | 4P (n, %) | Total (n, %) | | |
| Female | 17 | 24 | 41 | | |
| | 62.96 | 72.73 | 68.33 | | |
| Male | 10 | 9 | 19 | | |
| | 37.04 | 27.27 | 31.67 | | |
| Total | 27 | 33 | 60 | 0.6543 | 0.419 |

**Table-2:** Gender of participants (n = 60)

| Open Cholecystectomy | Group | | | Chi- squaretest | P-Value |
|---|---|---|---|---|---|
| | 3P (n, %) | 4P (n,%) | Tota (n,%) | | |
| No | 25 | 30 | 55 | | |
| | 92.59 | 90.91 | 91.67 | | |
| Yes | 2 | 3 | 5 | | |
| | 7.41 | 9.09 | 8.33 | | |
| Total | 27 | 33 | 60 | 0.06 | 0.8144 |

**Table-3:** Conversion to Open Cholecystectomy among participants (n = 60)

| AdditionalPort | Group | | | Chi- squaretest | P-Value |
|---|---|---|---|---|---|
| | 3P (n, %) | 4P (n, %) | Total (n,%) | | |
| No | 25 | 33 | 58 | | |
| | 92.59 | 100.00 | 96.67 | | |
| Yes | 2 | 0 | 2 | | |
| | 7.41 | 0.00 | 3.33 | | |
| Total | 27 | 33 | 60 | 2.52 | 0.112 |

**Table-4:** Need for Additional Port for completion of surgery (n = 60)

| Duration (minutes) | | | | |
|---|---|---|---|---|
| | 3P (n, %) | 4P (n, %) | Total (n, %) | |
| <=60 minutes | 12 | 14 | 26 | |
| | 48.00 | 46.67 | 47.27 | |
| 61-120 | 12 | 16 | 28 | |
| | 48.00 | 53.33 | 50.91 | |
| >120 | 1 | 0 | 1 | |
| | 4.00 | 0.00 | 1.82 | |
| Total | 25 | 30 | 55 | |
| | 100.0 | 100.0 | 100.0 | |
| Mean (SD) | 67(32.48) | 68.5(22.08) | | |
| Median (IQR) | 60(45-80) | 60 (55-85) | | |
| Range | 25-160 | 30-120 | P=0.8508 | |

**Table-5:** Duration of laparoscopy among participants (n = 55)

the 3-port and 4-port groups needed conversion to open cholecystectomy, respectively. There was no statistically significant difference between the two study groups regarding the conversion to open cholecystectomy (p = 0.814). Collectively, the primary reasons for conversion to open cholecystectomy were vascular adhesion between the inflamed gallbladder and small intestine (particularly duodenum), large intestine (particularly transverse colon), and gastric wall, frozen calot's triangle or long cystic duct.

Table 3 shows the distribution of study participants needing conversion to open cholecystectomy.

Table 4 shows the details about the need for additional ports required to complete the procedure. Overall, 3.3% of participants required an additional port. Further, as shown above, 7.4% of participants in the 3-port group and none of the participants in the 4-port groups required an additional port for completing the surgery. The difference in the proportion of participants requiring additional port for the completion of the surgery was statistically insignificant (p =0.112). The reasons for the need of additional port in the 3-port group were: difficult anatomy of Calot's triangle; distended Hartmann's pouch; and tortuous right hepatic artery.

Table 5 give the details about the time taken to complete the laparoscopy. For approximately half of all participants in both the 3-port group (48%) and 4-port group (46%), the


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| Complication | Group | | | Chi-Square Test | |
|---|---|---|---|---|---|
| | 3P, n (%) | 4P, n (%) | Total n (%) | Test | P-Value |
| Liver Bed Bleeding | | | | | |
| Yes | 0 | 0 | 0 | NA | NA |
| | 0.0 | 0.0 | 0.0 | | |
| No | 25 | 30 | 55 | | |
| | 100.0 | 100.0 | 100.0 | | |
| Stone spillage | | | | | |
| Yes | 3 | 2 | 5 | 0.47 | 0.4933 |
| | 12.00 | 6.67 | 9.09 | | |
| No | 22 | 28 | 50 | | |
| | 88.00 | 93.33 | 90.91 | | |
| | | Bile Leakage | | | |
| Yes | 6 | 4 | 10 | | |
| | 24.00 | 13.33 | 18.18 | 1.04 | 0.3071 |
| No | 19 | 26 | 45 | | |
| | 76.00 | 86.67 | 81.82 | | |
| Total | 25 | 30 | 55 | | |

**Table-6(a):** Distribution of participants based on the intraoperative complications (n=55)

| Anatomicalstructure | Group | | | Chi-Square Test | |
|---|---|---|---|---|---|
| | 3P, n (%) | 4P, n (%) | Total (n,%) | Test | P-Value |
| **Cystic Artery** | | | | | |
| Yes | 0 | 1 | 1 | 0.85 | 0.356 |
| | 0.00 | 3.33 | 1.82 | | |
| No | 25 | 29 | 54 | | |
| | 100.00 | 96.67 | 98.18 | | |
| Common Bile Duct | | | | | |
| Yes | 0 | 1 | 1 | 0.85 | 0.356 |
| | 0.00 | 3.33 | 1.82 | | |
| No | 25 | 29 | 54 | | |
| | 100.00 | 96.67 | 98.18 | | |
| Total | 25 | 30 | 55 | | |

**Table-6(b):** Distribution of participants based on the injury to surrounding organs (n=55)

laparoscopic cholecystectomy was completed within one hour. Further, only in 1 (4.0%) participant, the duration of laparoscopy was more than 2 hours. The mean duration of laparoscopy among the participants in the 3-port and the 4-port group was 67 and 68.5 minutes, respectively, and this difference was not significant (p=0.8508). The median time for laparoscopic cholecystectomy among participants in 3-port and 4-port groups was exactly equal (60 minutes).

Table 6 (a) shows the incidence of intraoperative complications encountered during laparoscopic cholecystectomy. There were few cases of oozing of blood in bothgroups which resolved spontaneously or with minimal pressure. Collectively, the incidence of bleeding from the liver bed, spillage of gallstone, and leakage of bile was0%, 9%, and 18%, respectively. Among the participants who were operated by the 3- port technique, the incidence of bleeding from the liver bed, spillage of gallstone, and leakage of bile were 0%, 12%, and 24%, respectively. Among the participants who were operated by the 4-port technique, the incidence of bleeding from the liver bed, spillage of gallstone, and leakage of bile were 0%, 6.7 %, and 13%, respectively. The difference in the proportion of participants in each of the 3-port and the 4-port group were statistically non-significant for any of the three complications (p>0.05). Bile leakage was seen incidentally due to slippage of the clip from the GB neck orremoving the complete GB. There was no bile leak from the cystic duct stump.

Table 6 (b) illustrates the injury to surrounding organs during the laparoscopic cholecystectomy. No surrounding organ was injured among the participants in the 3- port group. Only one participant (3.3%) encountered an injury to the surrounding organ (both cystic artery and common bile duct) during the 4-port laparoscopic cholecystectomy. The injury to the cystic artery was due to skeletonization of common hepatic duct or common bile duct and during adhesiolysis in calot's triangle. The difference in the proportion of participants encountering injury to surrounding anatomical structures was statically nonsignificant (p=0.356).

## DISCUSSION

For several unforeseen reasons, an LC needs to be converted to open cholecystectomy. This can happen irrespective of the number of ports, or the size of ports used during laparoscopic

cholecystectomy. In the present study, for various reasons, about 8.3% of participants needed conversion to open cholecystectomy for completion of the procedure. The reason being vascular adhesion between the inflamed gallbladder and small intestine (particularly duodenum), large intestine (particularly transverse colon) and gastric wall; frozen calot's triangle or long cystic duct. Groupwise: about 7.4% and 9.1% of participants in the 3-port and 4-port groups needed conversion to open cholecystectomy, respectively. However, there was no statistically significant difference between the two study groups regarding the conversion to open cholecystectomy (p = 0.728). Gupta V et al[8] reported that only 2% of participants (only 1 in 50 participants) each who underwent 3-port and 4- port LC needed conversion to OC. They further reported that the reason for conversion in the 3-port group was frozen Calot's triangle with the contracted gallbladder. Among participants who underwent 4-port LC the reason for conversion was bleeding from a cystic artery. Harsha et al[9] reported that none of the participants in either 3- or 4- port groups required conversion to OC. Trichak S[10] reported that only 2% of participants each in 3- and 4-port LC group required conversion to OC. Chalkoo M et al also reported that not even a single patient needed conversion to open cholecystectomy.[7] Al-Azawi D et al[11] reported that only 2.8% of participants in the 3- and 4-port group required conversion to OC. Cerci C et al[12] reported that 4.3% of participants each in the 3- and 4- port groups required conversion to OC. Kumar M et al[13] reported that 2.8% of participants in the 3-port and 2.6% in the 4-port group required conversion to OC.

Although the rate of conversion to OC in the present study was higher than other studies, nonetheless, like all other studies discussed here, the difference between the 3- and 4-port groups was statistically insignificant. As can be noted from the findings of other studies mentioned above, the difference in the proportion of participants needing conversion to OC was statistically insignificant in every study. This suggests that the need for conversion to OC is predominantly determined by the patient-level factors rather than the number or size of ports for LC. Simopolus C et al[14] analysed the records of a total of 1,804 patients who underwent LC over 8 years at a single hospital. They reported that overall, 5.4% of participants needed conversion to OC. Further, most of those who needed conversion to OC had acute inflammation of the gallbladder. Moreover, they observed that previous abdominal surgery, diabetes, raised white blood counts fever, raised total bilirubin levels were associated with conversion to OC. They concluded that the conversion to OC was determined by the presence of gallbladder pathology rather than the LC technique or number of ports. Rothman JP et al[15] conducted a systematic review and reported that the most important predictor of conversion to OC was the presence of gallbladder pathology (leading to either wall thickness, adhesion, contraction etc,.) or presence of acute inflammation as indicated by fever, raised TLC. Thus, it is the presence of pre-existing illness rather than the LC technique that determines the conversion to OC.

Therefore, in any given setting the rate of conversion to OC may vary, however, the rate of conversion will remain comparable among 3-port and the 4-port group as observed in several studies including the present study.

Similar to the reasons which require conversion of LC to OC, it may become necessary to add additional port(s) to complete the surgery. The most common reason for this is the presence of unforeseen complications during the procedure. In the present study overall, 7.4% of participants in the 3-port required an additional port for completing the surgery either due to difficult anatomy of Calot's triangle; distended Hartmann's pouch; or tortuous right hepatic artery. Mayir B et al[16] reported that an additional port was needed for 9% (9 out of 100) of participants who underwent 3-port laparoscopy. A total of 4 patients had adhesions, 1 each had; perioperative bleeding, cholecystitis, clip displacement, hydrops and difficult to visualize. Gupta V et al[8] reported that only 6% of participants (3 out of 50 participants) in the 3-port group required additional port for completion of surgery. Further, Gupta V et al. elaborated those 2 patients had dense adhesions in Calot's triangle, and 1 patient had an enlarged liver. Chalkoo M et al[7] reported that about 6% (3 out of 50) of participants required an additional port to complete the LC;2 participants had difficulty in dissecting Calot's triangle in acute cholecystitis and one participant had a mucocele. Similarly, Kumar P et al[17] reported that 6.7% of participants who underwent 3-port LC required an additional port to complete the surgery. Also, Sharma PK et al. reported that about 5% of participants who underwent 3-port LC required an additional port to complete the surgery.[18] Comparatively, Sinha et al. reported that only 2.5% of participants need an additional port for successfully removing the gallbladder. Azawi Al et al. reported that none of the participants needed an additional port for the completion of laparoscopic cholecystectomy.[11]

From the review of the findings of the above-mentioned studies, it appears that the factors which determine the need for additional port are similar to factors that determine the conversion of LC to open cholecystectomy. In addition, the successful completion of any surgery including 3-, 2- or single-port LC depends to a great degree on the expertise and confidence of the surgeon. Jointly, all these factors determine the rate of conversion to OC or the addition of more ports. This should be the reason for the varying degree of conversion rate observed among the studies discussed above.

One of the assumptions regarding reduced port LC is that it decreases the operative time. However, just like the need for conversion to OC or the need for additional port, the operative time depends on the gallbladder pathology, additional comorbidities, expertise & confidence of the surgeon. Lastly, the operative time also depends on how the total operative time was measured i.e., the starting and ending time.

In the present study for most participants in both group 3-port and 4-port, the surgical procedure was completed within one hour. Further, the mean duration of laparoscopy among the participants in the 3-port and the 4-port group was 67 and 68.5 minutes, respectively, and this difference was not significant (p=0.8508). The median time for laparoscopic cholecystectomy among both groups was the same (60

minutes) in both groups. Trichak et al[19] reported that the mean duration of LC in the 3- and 4- port groups was 59.22 and 57.65 minutes, however, this difference was statistically nonsignificant different (p = 1.64). Harsha HS et al[20] reported that the mean operating time in the three-port group was forty-four minutes and forty-seven minutes among the participants who underwent four-port LC (*P* = 0.073). It was also interesting that mean operative time was shorter for three-port LC, which does not correlate with previous studies. Nafeh AI et al[21] reported that the meantime for LC among participants who underwent the 3-port technique was 62 minutes and 65 minutes among participants who underwent the 4-port LC group (statistically insignificant). Akay et al[22] reported that the meantime for completing LC who underwent 3-port LC was 61.1 minutes and among those who underwent 4-port LC was 58.8 min. Chalkoo M et al[7] reported that among participants who underwent 3-port LC the meantime for surgery was 55 minutes.

Collectively, in the present study, the incidence of leakage of bile was 18%. Among the participants who were operated by the 3-port and 4-port technique, the incidenceof leakage of bile was 21% and 14%, respectively. The difference in the proportion of participants in each of the 3-port and the 4-port group were statistically non- significant (p>0.05). However, Gupta V et al[8] reported that bile spillage was found in18% of participants among the 3-port group and 22% participants in the 4-port group, respectively. This difference was however not statistically significant.

Collectively, in the present study, the incidence of bleeding from the liver bed was 0%in the participants operated by the 3-port and 4-port techniques both. Chalkoo M et al[7] about 8% of participants in their study had minor bleeding from the liver bed among participants operated by 3-port technique. Azawi AI et al[11] reported that incidence of bleeding from the liver bed was 0.4% and 1.9% among the participants in the 3-port and 4-port groups respectively. Mayir et al[16] reported that the bleeding from the liver bed was 2% among participants who underwent 3-port LC. Akay et al[22] reported that theincidence of bleeding from the liver bed was higher in the 3-port group (5.5%) thanthe 4-port group (4%).

Only one participant (3.7%) in the 4-port group encountered an injury to the cystic artery during laparoscopic cholecystectomy due to frozen calot's triangle or difficult anatomy. There was not even a single case of injury to surrounding anatomical structures among the participants in the 3-port group. The difference in the proportion of participants encountering injury to surrounding anatomical structures was statically nonsignificant (p=0.351). Akay et al[22] reported that only one patient (0.5%) in the 3- port group had an injury to the cystic artery.

Only one participant (3.7%) encountered an injury to the common bile duct during the 4-port laparoscopic cholecystectomy. There was not even a single case of injury to CBD among the participants in the 3-port group. The difference in the proportion of participants encountering injury to surrounding anatomical structures was statically nonsignificant (p=0.351). Trichak et al[10] did not encounter any case of CBD injury in any group in their study. Azawi DA et al[11] also did not report any unfortunate incidence of injury to CBD in either the 3-port or the 4-port groups. Only Akay et al[12] reported injury to CBD in both groups. The CBD injury rates were 3% in the 3-port group and 2% in the 4-port group.

## CONCLUSION

In conclusion, the 3-port technique is a safer alternative to the standard 4-port technique that offer many advantages with no increase or additional complications in the hands of an experienced surgeon. However, under any condition, if the need arise the surgeon should not hesitate toconvert a 3-port technique to a 4-port technique or convert a laparoscopic procedure into an open cholecystectomy. Any conversion or change in theprocedure should not be seen as a failure of the method, rather as a judgement of the surgeon to prioritize the life of the patient.

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