



**SUBCUTANEOUS EMPHYSEMA FOLLOWING LAPAROSCOPIC TOTALLY EXTRAPERITONEAL INGUINAL HERNIA REPAIR- A CASE SERIES**

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**ARTICLE INFO**

**Article History:**

Received 10<sup>th</sup> July, 2019

Received in revised form 2<sup>nd</sup>

August, 2019

Accepted 26<sup>th</sup> September, 2019

Published online 28<sup>th</sup> October, 2019

**ABSTRACT**

Although complications of laparoscopic totally extraperitoneal inguinal hernia repairs are well documented, the development of subcutaneous carbon dioxide emphysema is rarely reported. Numerous hypotheses were proposed for development of this complication however neither of them has exclusively postulated its genesis. This potentially lethal complication has to be diagnosed and managed promptly. We report a series of patients who developed subcutaneous emphysema, possible mechanism and ways to prevent it.

**Key words:**

Total extraperitoneal (TEP) repair, subcutaneous emphysema.

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**INTRODUCTION**

Laparoscopic inguinal hernia repair originated in early 1990s as laparoscopy gained foothold in general surgery.<sup>1,2,3,4,5</sup> Inguinal hernias account for 75% of all abdominal wall hernias, and with a lifetime risk of 27% in men and 3% in women. Laparoscopic totally extraperitoneal inguinal hernia repair is slowly gaining implementation and acceptance in surgical community. Advantages include reduced postoperative pain, diminished requirement for narcotics, earlier return to work.

However disadvantages of laparoscopic inguinal hernia repairs include a steeper learning curve, longer operating time, increased cost and necessity of general anaesthesia.<sup>6,7,8,9,10</sup> the recurrence rate of laparoscopic repair is less than 1% compared to 0.6-1.4% for open repairs.<sup>11,12</sup> Certain complications occur more frequently in certain repairs however overall complication rates are similar. Subcutaneous emphysema is a rarely mentioned complication.

In this present article we give a case series of patients developing subcutaneous emphysema following laparoscopic totally extraperitoneal hernia repair documented in a single unit in the department of general surgery in Safdarjung Hospital, New Delhi during May 2012 - October 2019. A total of 65 patients underwent laparoscopic inguinal hernia repair and subcutaneous emphysema was noted in 4 patients.

**MATERIAL AND METHODS**

**Inclusion criteria**

1. Patients above 18 years of age.
2. Patients operated for inguinal hernia using TEP complicated with subcutaneous emphysema.

**Exclusion criteria:-** all patients above 18 years operated for inguinal hernia using TEP approach and who did not present with subcutaneous emphysema (uncomplicated procedure).

**Results (Case Wise Presentation)**

**Case 1:** A 32 year old male patient was admitted with a left indirect complete reducible inguinal hernia for laparoscopic totally extraperitoneal inguinal hernia repair. He was a smoker with Body mass index of 23 with no known comorbidities or any previous surgical history. The patient had an uneventful induction and intubation. At the start of the procedure his end tidal CO<sub>2</sub> pressure was 36mm Hg and O<sub>2</sub> saturation of 100%. Three ports were used and preperitoneal space insufflated with a mean CO<sub>2</sub> pressure of 15 mmHg. An indirect hernia sac with omentum as content was identified and dissected before a 3D mesh was inserted. While closing, 86 minutes into the procedure, the patient saturation was still 100% but end tidal CO<sub>2</sub> pressure was elevated upto 57%. Physical examination revealed subcutaneous emphysema of groin, abdomen and lower chest. Patient was extubated and shifted to recovery and following chest x rays revealed subcutaneous emphysema without any pneumothorax up to lower chest which was managed conservatively. Subcutaneous emphysema resolved clinically within 24 hours and patient was discharged the

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following day. It was proposed that long surgical time and high CO<sub>2</sub> insufflation pressure was the reason for subcutaneous emphysema.

**Case 2:** A 26 year old male patient was admitted with a right indirect reducible incomplete inguinal hernia for laparoscopic totally extraperitoneal inguinal hernia repair. He was non-smoker and non-alcoholic with Body mass index of 27. He gave history of gastro esophageal reflux disease and was on pantoprazole 40mg OD dosage with no other comorbidities or any previous surgical history. The patient had an uneventful induction and intubation. At the start of the procedure his end tidal CO<sub>2</sub> pressure was 41mm Hg and O<sub>2</sub> saturation was 100%. Three ports were used and preperitoneal space insufflated with a mean CO<sub>2</sub> pressure of 15 mmHg. An indirect hernia sac was identified with small bowel as content, which was reduced, dissection was completed and 3D mesh was inserted. While closing, 74 minutes into the procedure, the patient O<sub>2</sub> saturation was 99% but end tidal CO<sub>2</sub> pressure was elevated up to 62%. Physical examination revealed subcutaneous emphysema up to upper abdomen. Patient was extubated and shifted to recovery. Subcutaneous emphysema resolved clinically within 12 hours of conservative management and patient was discharged within 2 days. It was proposed that elevated CO<sub>2</sub> insufflation pressure and obesity was most probable cause for subcutaneous emphysema.

**Case 3:** A 55 year old male patient was admitted with right direct reducible inguinal hernia for laparoscopic totally extraperitoneal inguinal hernia repair. He was a smoker and occasional drinker with Body mass index of 24. He gave history of diabetes mellitus type 2 and hypertension since 5 years on regular medication and was cleared from cardiology for surgery. He had significant surgical history of laparoscopic cholecystectomy 10 years back. The patient had an uneventful induction and intubation. At the start of the procedure his end tidal CO<sub>2</sub> pressure was 37 mmHg and O<sub>2</sub> saturation was 100%. Three ports were used and preperitoneal space was insufflated with a mean CO<sub>2</sub> pressure of 15 mmHg. A direct inguinal hernia sac with omentum as content was identified, contents reduced. Polypropylene mesh was inserted. While closing, 65 minutes into the procedure, the patient's O<sub>2</sub> saturation was 99% with end tidal CO<sub>2</sub> pressure of 64 mmHg. Physical examination revealed subcutaneous emphysema involving groin, abdomen upto lower chest. Patient was extubated and shifted to recovery, following chest x rays showed subcutaneous emphysema up to lower chest without evidence of pneumothorax. Subcutaneous emphysema resolved within 36 hours and patient was discharged after 2 days. It was proposed that elevated CO<sub>2</sub> insufflation pressure and old age was the most probable cause for subcutaneous emphysema

**Case 4:** A 37 year old male patient was admitted with bilateral reducible inguinal hernia for laparoscopic totally extraperitoneal inguinal hernia repair.

Right sided hernia was around 12\*5cm in size, pyriform shaped, reducible. Left sided hernia was around 5\*3cm in size, not reaching up to scrotum, bubonocele. He was a non-smoker and non-alcoholic with body mass index of 24. He had no known comorbidities or any previous surgical history. The patient had an uneventful induction and intubation. At the start of the procedure his end tidal CO<sub>2</sub> pressure was 38mmHg and O<sub>2</sub> saturation was 100%. Four ports were used and preperitoneal space was insufflated with a mean CO<sub>2</sub> pressure of 12 mmHg. A right sided pantaloon's hernia and left sided bubonocele was identified, dissected, contents reduced and polypropylene mesh was inserted. While closing, 108 minutes into procedure, the patient's O<sub>2</sub> saturation was 99% and end tidal CO<sub>2</sub> pressure was upto 73 mmHg. Arterial blood gas analysis was done which revealed mild hypercarbia. The fraction of inspired O<sub>2</sub> was increased to 100%, and surgery was completed rapidly. On physical examination subcutaneous emphysema was noted in groin, abdomen, chest up to neck and face. After completion of procedure, end tidal CO<sub>2</sub> pressures gradually reduced, and patient was extubated after 20 minutes and shifted to recovery. Post-operative x rays revealed subcutaneous emphysema up to neck region. However subcutaneous emphysema resolved spontaneously within 48 hours and patient was discharged after 3 days. Even though CO<sub>2</sub> insufflation pressures were kept low in this case subcutaneous emphysema was noted probably because of prolonged operative time.

A summary of important findings in these above cases are summarized in a tabular form below:

## DISCUSSION

There are a number of advantages and disadvantages to laparoscopic surgery compared to open approach. However depending on surgeon's experience, a longer operative time maybe needed. Other disadvantages include possibilities of hemorrhage, perforation into visceral organs and cardiac arrest from gas embolism.<sup>13</sup>

Several gases have been used for insufflation however CO<sub>2</sub> has proven to be the safest of these gases because it does not support combustion and is more soluble in blood. Some reported complications include dysrhythmias, hypercapnia, atelectasis, pneumothorax, pneumomediastinum and subcutaneous emphysema.<sup>14,15,16</sup>

Subcutaneous emphysema is defined as the presence of gas (CO<sub>2</sub>) within the tissue beneath the skin. It is identified by visualizing a smooth bulging of skin and by palpation that produces an unusual crackling sensation. A 4- point scale comparing varying degrees<sup>17</sup> has been elicited

SN	Age/sex	CO <sub>2</sub> insufflation pressure	Finding=subcutaneous emphysema	ETCO <sub>2</sub> start-end(mmHg)	Operative time(minutes)	Probable mechanism for subcutaneous emphysema
1	32yr/M	15 mmHg	Groin, abdomen Upto lower chest	36, 57	86	High CO <sub>2</sub> insufflation pressure, prolonged operative time
2	26yr/M	15 mmHg	Groin and upper abdomen	41,62	74	High CO <sub>2</sub> insufflation pressure, obesity leading to improper sealing of trocar
3	55yr/M	15 mmHg	Groin, abdomen up to lower chest	37, 64	65	High CO <sub>2</sub> insufflation pressure, old age
4	37yr/M	12 mmHg	Groin, abdomen, chest up to neck and face	38, 73	108	Prolonged operative time

0= no subcutaneous emphysema

1= mild emphysema with crepitus at trocar insertion sites or in the groin

2= marked emphysema with crepitus extending to the abdomen and thighs

3= massive emphysema extending to the chest or neck and face

Although subcutaneous emphysema is usually harmless as long as hypercarbia is not a significant problem, cases have been reported where it has been associated with potentially life threatening complications like pneumothorax, pneumopericardium and mechanical displacement of endotracheal tube.<sup>[18-22]</sup> Its incidence has been reported to be between 2.2%<sup>23</sup> and 56%<sup>24</sup>. Since CO<sub>2</sub> is a rapidly absorbable gas, emphysema has been reported to almost always completely disappear by 2-4 days.<sup>23,25</sup>

It is generally recognized that CO<sub>2</sub> induced subcutaneous emphysema is more common after extraperitoneal procedures.<sup>26,27</sup> Other factors include higher insufflation pressures, prolonged surgical time and old age.<sup>25</sup>

Numerous potential mechanisms were proposed to explain these complications. 1) all trocars pass through two layers in the abdominal wall, skin and muscle layer, which act as seals around them. If, however, the inner tissue seal is loose and the skin seal is tight, CO<sub>2</sub> leaks into subcutaneous tissue. 2) Excessive subcutaneous depth, the trocar cone does not reach the depth required to form a seal at the level of anterior rectus sheath. 3) too small skin incision does not allow the trocar to be advanced enough to plug the inner fascial incision. 4) Manipulation of instruments can lead to loosening of seal and CO<sub>2</sub> leak. 5) Creation of false passage during trocar insertion when multiple attempts have been made. 6) unusual causes include spontaneous rupture of a pre-existing bulla or bleb.<sup>[28]</sup> Management of this complication may be divided into two components: diagnostic and therapeutic. A decrease in oxygen saturation and a rise in end tidal CO<sub>2</sub> pressure should be regarded with caution. A prompt patient examination is necessary to detect asymmetrical chest movements. The crepitus of subcutaneous emphysema is often palpable or audible. An urgent x ray will confirm the diagnosis. Other investigations include arterial blood gases, electrocardiography, computed tomography.

The use of nitrous oxide should be stopped immediately, the fraction of inspired O<sub>2</sub> increased to 100% and the patient hyperventilated under close monitoring. Depending on the situation, CO<sub>2</sub> insufflation should be discontinued or reduced.<sup>[29]</sup> If cervicofacial emphysema is present, laryngoscopy should be performed before extubation to exclude potential pharyngeal emphysema and airway obstruction.<sup>[30]</sup>

Following preventive measures help to reduce the chances of developing subcutaneous emphysema: 1) sharp trocars to be inserted at first attempt to prevent creation of false passages. 2) Careful monitoring of end tidal CO<sub>2</sub> pressure monitoring. 3) CO<sub>2</sub> insufflation pressure to be kept as low as possible. 4) Blunt trocars should be placed so as to plug the inner fascial incision. 5) larger skin incisions helps in leakage at skin seal and reduce the risk of CO<sub>2</sub> being under pressure in subcutaneous plane.

## CONCLUSION

Subcutaneous emphysema complicating laparoscopic totally extraperitoneal inguinal hernia repair although considered rare, its incidence is likely to increase as the procedure gains popularity. A number of factors contribute to its development and understanding of these factors, some of which are preventable, can help reduce the incidence. Management includes early diagnosis and supportive management. Both surgeons and anaesthetists should remain vigilant because it the potential to cause serious morbidity or even death.

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**How to cite this article:**

Dheer S. Kalwaniya *et al* (2019) 'Subcutaneous Emphysema Following Laparoscopic Totally Extraperitoneal Inguinal Hernia Repair- A Case Series', *International Journal of Current Advanced Research*, 08(10), pp. 20324-20327.  
DOI: <http://dx.doi.org/10.24327/ijcar.2019.20327.3967>

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