Section: General Surgery

Original Research Article

# EFFECT OF DIRECT DEFECT CLOSURE DURING LAPAROSCOPIC INGUINAL HERNIA REPAIR (TAPP PLUS TECHNIQUE) ON POST-OPERATIVE OUTCOMES

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## ABSTRACT

**Background:** Hernia is derived from the Latin word for rupture. Although a hernia can occur at various sites of the body, these defects most commonly involve the abdominal wall, particularly the inguinal. Inguinal hernias are classified as direct or indirect inguinal hernia according to their mechanism and anatomical characteristics. With the increase in popularity of laparoscopes, surgeon and patient preferences have changed toward laparoscopic repair of hernia very rapidly. Seroma is most common complication of laparoscopic hernia repairs.. The risk of postoperative seroma after transaction of the inguinal hernia sac during laparoscopic hernia repair is found to be higher than in the patients with complete dissection of the sac. The presence of a direct defect has been noted to be associated with higher rates of Seroma formation and recurrence. Direct closure of the defect attempts to reduce the Seroma formation and recurrence in these patients for direct hernias, there is clear evidence to support the findings that when the lax transversalis fascia is inverted and the dead space volume is reduced by a direct suture closure of the defect, the incidence of Seroma is significantly reduced. Primary Objective is to assess and compare the Seroma formation and recurrence with TAPP PLUS technique with TAPP technique (closure of defect with non-closure of defect). Secondary objectives are to determine the success rates in TAPP PLUS Technique and TAPP TECHNIQUE (closure of defect with non-closure of defect). 2.To compare the efficacy of TAPP PLUS TECHNIQUE with TAPP Technique (closure of defect with non-closure of defect).3.To provide the future references for the surgeons in the treatment of hernia sacs during laparoscopic repair. **Materials and Methods:** This prospective study "Effect of Direct Defect closure during laparoscopic inguinal hernia repair (TAPP PLUS TECHNIQUE) on post–operative outcomes" was conducted in the Post Graduate Department of General Surgery, Government Medical College, Jammu to evaluate and compare the safety and efficacy of the TAPP PLUS Technique with TAPP Technique in treating Direct inguinal hernias. All the patients subjected to laparoscopic transabdominal preperitoneal hernia repair were considered. The data was collected on factors such as patient age, sex and medical history, as well as the surgical technique used, the length of hospital stay, and the occurrence of complications following the procedure. Patients were divided into two groups, 20 patients in each group, one group underwent direct defect closure and another 20 patients in other group underwent non- closure of hernia defect. The results were compared in both groups. **Result:** In the hernial direct defect closure group there was decreased incidence of seroma formation as compared with hernia direct defect non-closure group. While there was statistically no difference on recurrence and pain between the two groups. **Conclusion:** In the present study, the incidence of seroma formation was significantly lower in the defect closure group compared to the non-closure group at 1monthfollow-up.

The study demonstrates that direct defect closure during laparoscopic inguinal hernia repair is associated with lower rates of seroma formation compared to the non-closure of defect. The findings suggest that closure of defect group should be the preferred approach to minimize the risk of this common postoperative complications though it takes longer time. The findings of our study will be helpful in guiding the surgical management of inguinal hernias, especially in the choice between defect closure versus non-closure group during laparoscopic repair. Further large-scale prospective studies are needed to corroborate our findings and strengthen the evidence on the optimal management of the hernia sac during laparoscopic inguinal hernia repair.

## INTRODUCTION

Hernia is not a disease of modern society, its occurrence was reported during early 16th century and it was recognized as a surgical disease by Praxagoras of Kos. (Saxena P and Patel K 2020). [9] Hernia is derived from the Latin word for rupture. A hernia is defined as an abnormal protrusion of an organ or tissue through a defect in its surrounding walls. Although a hernia can occur at various sites of the body, these defects most commonly involve the abdominal wall, particularly the inguinal region (Sabiston edn 2021).{8}. Inguinal hernias are classified as direct or indirect inguinal hernia according to their mechanismand anatomical characteristics region (Özdemir Ketal.,2025).{4}. Indirect hernia out numbers direct hernia by about 2:1. The laparoscopic approach for inguinal hernia was started in the 1990s and was adopted rapidly by surgeons all over the world (Khan MW S et al., 2023).[3]. Now it a recommended approach for primary unilateral inguinal hernia, bilateral inguinal hernia and recurrent inguinal hernia after anterior approach with open repair due to a lower incidence of post-operative pain and chronic pain. (Claus C et al., 2020).[2]. Widely practiced methods in laparoscopy include the Totally Extraperitoneal (TEP) and the Transabdominal Preperitoneal (TAPP) repair (Usmani F et al., 2020).[10]

Seroma is the earliest and most common complication of laparoscopic inguinal hernia repair and it can mimic an early recurrence (Powell BS et al., 2015).[7]. It has been reported that the incidence of post-operative Seroma is 10-15%, however seroma can generally be absorbed within three months after surgery (Tai HC et al., 2011). The formation of Seroma is closely related to the size of the hernia sac and the duration of operation. Other risk factors associated with seroma formation include the presence of a medial defect, a large defect size, mesh fixation with glue, inguinoscrotal hernia, and a residual hernia sac. (Usmani F et al., 2020).[10]. The presence of a direct defect has been noted to be associated with higher rates of Seroma formation and recurrence. Direct closure of the defect attempts to reduce the Seroma formation and recurrence in these patients for direct hernias, there is clear evidence to support the findings that when the lax transversalis fascia is inverted and the dead space volume is reduced by a direct suture closure of the defect, the incidence of Seroma is significantly reduced (Binyu L et al., 2023).[1]. In case of M3 hernias, a lack of adequate overlap substantially elevates the risk of recurrence unless the gap is closed by suturing. In nutshell, Direct closure of the hernia defect in case of direct inguinal hernias reduces the seroma formation as well as the recurrence of the hernia as confirmed by various studies. The present study aims to reduce the seroma formation and recurrence by the direct closure of the defect laparoscopically by TAPP PLUS technique.

## MATERIALS AND METHODS

This prospective study was conducted in the Post Graduate Department of General Surgery, Government Medical College, Jammu to evaluate and compare the safety and efficacy of the TAPP PLUS Technique with TAPP Technique in treating Direct inguinal hernias.

All the patients subjected to laparoscopic transabdominal preperitoneal hernia repair were considered. The data was collected on factors such as patient age, sex and medical history, as well as the surgical technique used, the length of hospital stay, and the occurrence of complications following the procedure.

**The preoperative workup consists of:**

- History and complete physical examination of patients
- Baseline investigations i.e. CBC /LFT /KFT /Serology Markers /ECG.
- Radiology: X-ray chest, ultrasound abdomen for prostate size, residual urine and hernia defect size according to EHS classification.

EHS (European Hernia Society Classification) (M represents medial or direct inguinal hernia).

M1 represents less than or equal to one finger.
M2 represents one-two fingers.
M3 represents more than or equal to three fingers.

**Study Design:** Prospective Study

**Duration of study:** 1 Year (1st May 2024 to 30thApril 2025).

**Sample Size:** 40

**Inclusion criteria:**

All patients above 18 years of age with Direct inguinal hernia defects equal to or larger than 2 cm were selected into either the closure group or the non-closure group who were willing to participate in the


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study with primary inguinal hernia and fitness for anesthesia under ASA grade 1and grade 2.

**Exclusion criteria:**

- Patient not fit for Anesthesia (American society of Anaesthesiologists) ASA grade 3 andgrade 4.
- Patients who underwent repair for strangulated hernia, incarcerated hernia, recurrent and indirect hernia.
- Patients with Prostatism, chronic cough.
- Patients not given consent.
- Patients below 18 years of age.
- Patients with renal failure, coagulopathy, metastatic disease and cardiovascular disease.

**Operative Technique**

The same surgeon performed all the procedures. All patients were operated under General anesthesia. The procedure for laparoscopic inguinal hernia surgery was performed in strict accordance with the guidelines for laparoscopic (TAPP) treatment of inguinal hernia stipulated by the International Endohernia Society (IEHS). All cases with direct hernia defects equal to or larger than M2 were selected into the closure group while the defects lesser than M2 were selected into the non-closure group. The direct defect closure was performed using a non-absorbable polypropylene barbed monofilament size 2-0 suture and the pseudo sac was pulled and incorporated in the closure. Light weight, macro-porous polypropylene mesh 15×12 cm was used.

**Statistical analysis:** The recorded data was compiled and entered in a spreadsheet. (Microsoft Excel) and then exported to data editor of SPSS Version 20.0 (SPSS Inc., Chicago, Illinois, USA). Continuous variables were expressed. Mean±SD and categorical variables were summarized as frequencies and percentages. The chi-square test was employed to determine the Association of most common allergens with different parameters. Graphically the data was presented by bar and pie diagrams.

## RESULTS

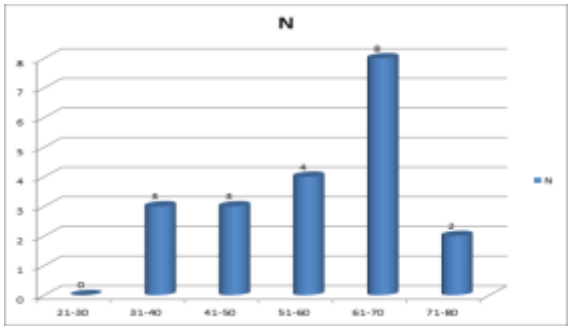


**Figure 1: Age Distribution (Defect-closure)**

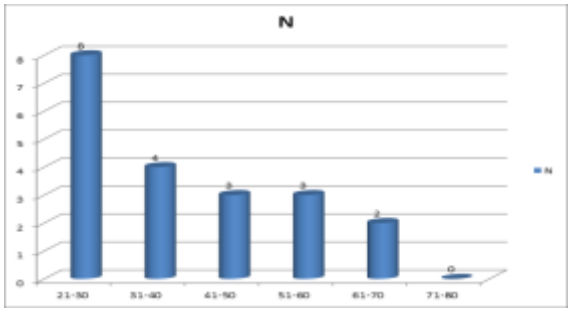


**Figure 2: Age Distribution (Non-closure group)**

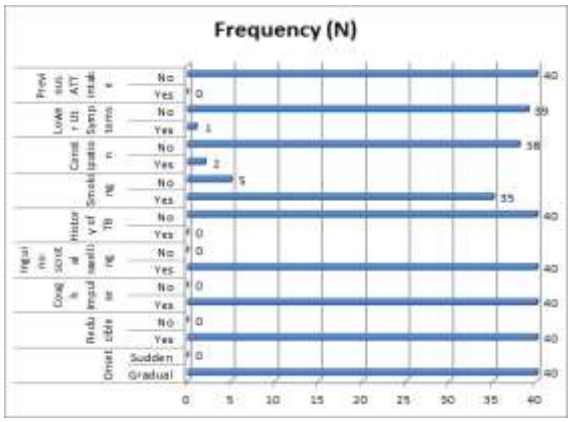


**Figure 3: Clinical Features**

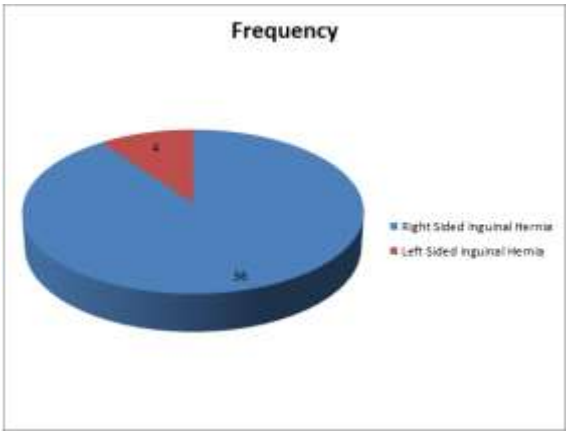


**Figure 4: Diagnosis**

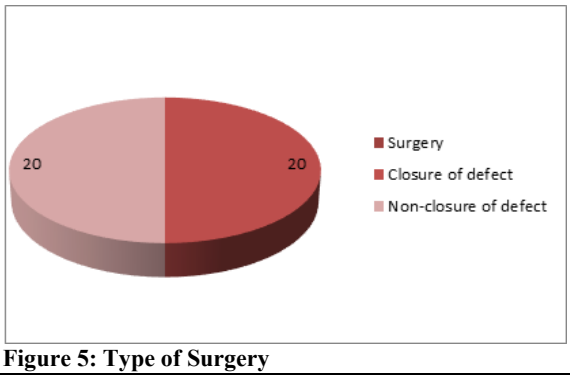


**Figure 5: Type of Surgery**

**Table 1: Age Distribution for Patients who underwent Direct defect closure**

| Age Group | N | (%) |
|---|---|---|
| 21-30 years | 0 | 0 |
| 31-40 years | 3 | 15 |
| 41-50 years | 3 | 15 |


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| | | |
|---|---|---|
| 51-60 years | 4 | 20 |
| 61-70 years | 8 | 40 |
| 71-80 years | 2 | 10 |

The majority of the participants 8 (40%) were in the in the age group 61-70 years followed by 4 (20%) in the 51-60 years age group, 3 (15%) in the age groups 41-50 and 31-40 years and 2 (10%) in age group 71-80 years.

**Table 2: Age Distribution for Patients who underwent non- closure of defect**

| Age Group | N | (%) |
|---|---|---|
| 21-30 years | 8 | 40 |
| 31-40 years | 4 | 20 |
| 41-50 years | 3 | 15 |
| 51-60 years | 3 | 15 |
| 61-70 years | 2 | 10 |
| 71-80 years | 0 | 0 |

The majority of the participants 8 (40%) were in the in the age group 21-30 years followed by 4 (20%) in the 31-40 years age group, 3 (15%) in the age groups 41-50 and 51-60 years and 2 (10%) in age group 61-70 years.

**Table 3: Clinical Features**

| | Clinical Features | Frequency (N) | Percent (%) |
|---|---|---|---|
| Onset | Gradual<br>Sudden | 40<br>0 | 100<br>0 |
| Reducible | Yes<br>No | 40<br>0 | 100<br>0 |
| Cough Impulse | Yes<br>No | 40<br>0 | 100<br>0 |
| Inguino-scrotal swelling | Yes<br>No | 40<br>0 | 100<br>0 |
| History of TB | Yes<br>No | 0<br>40 | 0<br>1OO |
| Smoking | Yes<br>No | 35<br>5 | 87.5<br>12.5 |
| Constipation | Yes<br>No | 2<br>38 | 5<br>95 |
| Lower Ut Symptoms | Yes<br>No | 1<br>39 | 2.5<br>97.5 |
| Previous ATT intake | Yes<br>No | 0<br>40 | 0<br>40 |

The mean duration of onset was 7.45±3.82 months (Range=2-14 months). All the patients reported gradual onset, inguinoscrotal swelling, reducibility and positive cough impulse. 35(87.5%) were smokers, 2(5%) patients complained of constipation and 1(2.5%) reported lower urinary tract symptoms. There was no history of ATT intake in any patient.

**Table 4: Clinical Diagnosis**

| Diagnosis | Frequency | Percentage (%) |
|---|---|---|
| Right Sided Direct Inguinal Hernia | 36 | 90 |
| Left Sided Direct Inguinal Hernia | 4 | 10 |
| Total | 40 | |

There were 36(90%) cases of right sided Direct inguinal hernia and 4(10%) cases of left sided Direct inguinal hernia. The mean intra-operative size of the hernia was 2.087 cm (Range=1.- 3 cm).

**Table 5: Surgery**

| Surgery | Frequency | Percentage (%) |
|---|---|---|
| Closure of defect | 20 | 50 |
| Non-closure of defect | 20 | 50 |

**Table 6: Comparison Of Duration of Surgery**

| Duration of surgery (minutes) | Group | N | Mean | Std. Deviation | Statistical significance | |
|---|---|---|---|---|---|---|
| | | | | | t-value | P-value |
| | Closure of defect | 20 | 57.2500 | 3.43166 | 29.36 | <0.001 |
| | Non- closure of defect | 20 | 31.0000 | 2.05196 | | |


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The mean duration of the surgery for closure of the hernia defect was 57.25 ±3.43 minutes and the mean duration of surgery for non-closure of defect group was 31 ±2.05 minutes. Statistical analysis using independent t-test showed that there was a statistically significant difference in mean duration of surgery between the two types of surgeries(P<0.001). The mean duration for closure of the defect was longer than that for non-closure of the defect.

**Table 7: Comparison of Hospital stay duration (days)**

| Groups | N | Mean | Std. Deviation | P value |
|---|---|---|---|---|
| Closure of the defect | 20 | 1.0000 | .00000 | --------- |
| Non-closure of the defect | 20 | 1.0000 | .00000 | ---------- |

P-value cannot be computed as the standard deviations of both groups are 0.
The mean duration of hospital stay in both types of surgery was 1 day.

**Post-Operative Complications**

**Table 8: Comparison Of Complications (Seroma formation) At Follow-up 1 month**

| Seroma Formation | Groups | | | | Total | | Statistical significance | |
|---|---|---|---|---|---|---|---|---|
| | Closure of the defect | | Non-closure of the defect | | | | Chi. Sq. value | P-value |
| | N | % | N | % | N | % | 4.800 | 0.028 |
| No | 18 | 90.0 | 12 | 60.0 | 30 | 75.0 | | |
| Yes | 2 | 10.0 | 8 | 40.0 | 10 | 25.0 | | |
| Total | 20 | 100.0 | 20 | 100.0 | 40 | 100.0 | | |

The follow-up was done at one, three and six months. At one month follow-up, there was seroma formation in 2 (10%) cases of defect closure group, and seroma formation in 8(40%) cases of non-closure group. Statistical analysis using the chi-square test showed that there was a statistically significant difference in the occurrence of seroma formation between two types of surgeries at 1 month follow-up (chi-square=4.800, P-value= 0.028). the occurrence of seroma formation was significantly higher in the defect non-closure group at 1 month.
At 6 month follow-up, there was again no seroma-formation in any of the two groupsi.e. defect closure or defect non-closure group.

**Table 11: Comparison Of Complications (Recurrence) At Follow-up 1 month**

| Recurrence | Group | | | | | |
|---|---|---|---|---|---|---|
| | Closure of defect | | Non-closure of defect | | Total | |
| | N | % | N | % | N | % |
| No | 20 | 100.0 | 20 | 100.0 | 40 | 100.0 |
| Total | 20 | 100.0 | 20 | 100.0 | 40 | 100.0 |

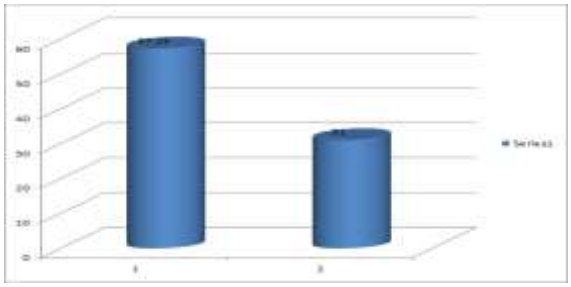

**Figure 6: Mean Duration of Surgery(in Minutes)**

At 1 month follow-up, there was no recurrence in any of the two groups i.e. defect closure or defect non-closure group.
At follow-up 3 month there was no recurrence in any of the two groups i.e. defect closure or defect non-closure group.
At 6 month follow-up there was no recurrence of hernia in Direct defect closure group while recurrence of hernia was seen in 1 (5%) cases of defect non-closure group. However, it was statistically in significant (chi-square=1.025, p-value=0.313).

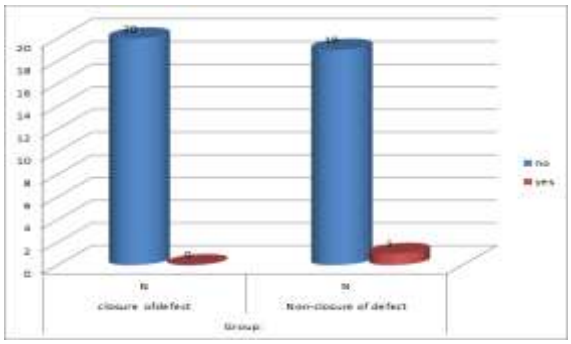

**Figure 7: Post operative complications (Recurrence) at 6 months follow-up**

- At 1month follow-up there was extreme pain in two(10%) cases of defect closure group while one (5%) case complained of pain in non-closure group, statistically it was insignificant (P-value <0.212).
- At 3rd month and 6th month follow-up there was no pain in either of the two groups.


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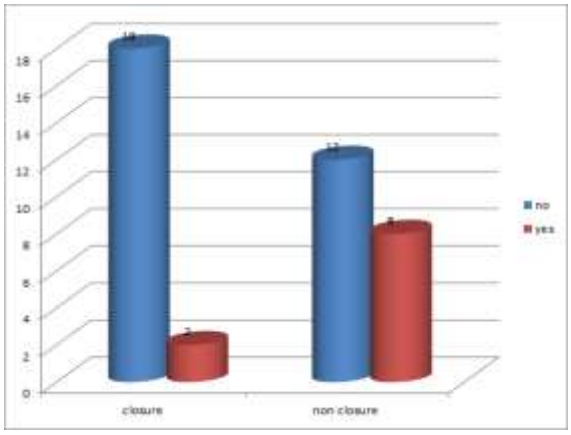


**Figure 8: Post operative complications (Seroma formation) at 1 month follow-up**

At 3rd month follow-up, there was no seroma-formation in any of the two groups.

## DISCUSSION

Seroma formation, recurrence and pain are the most common complications and major challenges in hernia surgery, and cause patient discomfort and frustration through extensive research and years of perfecting surgical techniques and procedures, the recurrence rate and seroma formation has decreased (Peterson N et al., 2022).

Postoperative seroma is an issue that emerged after the popularization of laparoscopic hernia repair. Pub-med searches of the timeline of seroma-related publication confirm this trend. Despite the fact that most seromas resolve spontaneously and have no impacton the final convalescence, seromas significantly and negatively impact patients' operative experiences, leading to misconceptions and medical lawsuits. Decreasing the postoperative seroma is a substantial subject that deserves further intensive research. The incidence of seromas can be significantly reduced intensive research. The incidence of seromas can be significantly reduced by the inversion and suturing of extended transversalis fascia in case of directlarge hernias. Open inguinal hernia repairs are rarely associated with seromas, we hypothesize that internal ring closure contributes to this result. Another advantage of internal ring closure is reinforcement repair. Formerly surgeons would leave the defect patent and perform repair only with mesh coverage, which is bridging repair. For small to medium defects (<3cm), this weakness could be counteracted by sufficient overlapping of the mesh. However, according to Laplace's law, as defects increase in size, the chance of mesh protrusion increases, and this weakness is enhanced by heavy-weight mesh or fixation measures. So internal ring closure turns a bridging repair into a reinforcement repair, which makes the repair more reliable and theoretically lowers the recurrence rate. Laparoscopic internal ring suturing has been seen to be safe and effective for the treatment of inguinal hernia in adolescents (Pogorelic Z et al., 2022).[6].

The literature reported that for the treatment of direct hernia under laparoscopy, the direct hernia cyst was eliminated by suturing the internal ring, which reduced the incidence of postoperative seroma and did not increase the risk of postoperative infection, pain or recurrence.

There have been several reported studies which have undertaken to evaluate the efficacy of Direct Defect closure in patients with Direct inguinal hernia, most studies lack sufficient power.

In the present study, follow-up was done at 1month, 3 months and 6 months. At follow-up 1 month, there were 2 cases (10%) seroma formation in Direct Defect closure group while 8 cases (40%) seroma formation in non-closure group which was managed with conservatively. At follow-up 3rd month and 6thmonth, there was no seroma formation. These findings were similar to those of Usmani F et al., 2020.

The present study showed that at 1month follow-up, two patients complained of extreme pain in the Direct Defect closure group, while one patient complained of pain in non-closure group. However, these results were statistically insignificant. The patients who presented with post-operative pain in the present study were extremely thin patients. These findings were consistent with other studies in which there was no association of pain with Direct Defect closure or non-closure technique (Zhu Y et al., 2019;Usmani F et al., 2020).[11],[10].

The present study showed no recurrence at 1st and 3rd month follow-up visits in both the Direct Defect closure as well as in Defect non-closure group. However, at follow-up 6th month there was no recurrence in Direct Defect closure group but there was recurrence in one patient (5%) in Defect non-closure group. This is statistically insignificant. These findings were similar to those of Binyu L et al., 2023 in whom patients were divided into inner ring closure group and non-closure group for inguinal hernia repair.

The present study showed that there is effective and significant reduction in post-operative seroma formation in cases of direct inguinal hernia repair done by laparoscopic technique as compared to Defect non-closure group.

There was no significant effect on recurrence and postoperative pain in closure or non-closure group in the present study.

**Summary**

The present prospective study was conducted in the Post-Graduate Department of General Surgery Government Medical College, Jammu with effect from 1st May 2024 to 30th April 2025 to assess the effect of Direct closure of hernial defect and non-closure of hernial defect during laparoscopic Direct inguinal hernia repair on seroma formation and recurrence. In the study, 40 patients who were subjected to laparoscopic Transabdominal preperitoneal (TAPP) hernia repair were considered. The main findings of the study are as follows:


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1. There were 40 participants in the study with a mean age of 54.55±8.638 years (Range=30-70 years).
2. The mean duration of onset was 7.45±3.8 months (Range=2-21 months). All the participants reported gradual onset, swelling, reducible and cough impulse.
3. Out of the 40 participants, 35 (87.5%) were smokers, 2 (5%) reported constipation and 1 (2.5%) reported lower UT symptoms.
4. There were 36 (90%) cases of right-sided indirect inguinal hernia and 4 (10%) cases of left-sided indirect inguinal hernia.
5. The mean intra-operative size of the hernia was 2.087±0.31 cm (Range=1-3 cm).
6. Out of the 40 surgeries performed 20 (50%) were defect-closure group and 20 (50%) were non-closure defect.
7. The mean duration of defect closuresurgery was 57.25±3.43 minutes and the mean duration of non-closure surgery was 31.00±2.05 minutes. The mean duration of defect closure surgery was significantly longer than that of non-closure group.
8. The occurrence of Seroma formation was significantly higher in the non-closure group compared to the defect closure group.
9. All the complications were managed conservatively.
10. The mean duration of hospital stay in both types of surgery was 1 day.
11. The follow-up was done at 1st month, 3rd month and 6th month.
12. At 1 month follow-up there was seroma formation in 2 cases (10%) among Direct Defect closure group while in non-closure group there were 8 cases (40%) of seroma formation. The formation of seroma was higher in Defect non-closure group as compared to Direct defect closure group.
13. Post-operative USG findings were normal in 18 cases (90%) of Direct defect closure group and in 12 cases (60%) of non-closure group. Seroma formation was seen in 2 cases (10%) of Direct Defect closure group, while 8 cases (40%) of non-closure group.

## CONCLUSION

In the present study, the incidence of seroma formation was significantly lower in the defect closure group compared to the non-closure group at 1monthfollow-up. The study demonstrates that direct defect closure during laparoscopic inguinal hernia repair is associated with lower rates of seroma formation compared to the non-closure of defect. The findings suggest that closure of defect group should be the preferred approach to minimize the risk of this common postoperative complications though it takes longer time.

The findings of our study will be helpful in guiding the surgical management of inguinal hernias, especially in the choice between defect closure versus non-closure group during laparoscopic repair. Further large-scale prospective studies are needed to corroborate our findings and strengthen the evidence on the optimal management of the hernia sac during laparoscopic inguinal hernia repair.

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