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# The Efficacy and Safety of Robotic Vs Laparoscopic Inguinal Hernia Repair, a Systematic Review and Meta-analysis

Taslim Aboudou[1,2,3,4#], MeixuanLi[3,4#,] WenceZhou[1,2,] Zeliang Zhang[1,2,] Shizhong Wang [5*], KehuYang[3,4*]

[1]The First School of Clinical Medicine, Lanzhou University, Lanzhou, China

[2]The First Hospital of Lanzhou University, Lanzhou University, Lanzhou, China

[3]Evidence Based Medicine Center, School of Basic Medical Sciences, Lanzhou University, Lanzhou, China

[4]Key Laboratory of Evidence Based Medicine and Knowledge Translation of Gansu Province, Lanzhou, 730000, China

[5]Department of orthopedics, Wuwei People's Hospital, Wuwei, China.

*: Correspondence: Kehu Yang, Tel: 13893117077; Shizhong Wang, Tel: 13893507777;

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**Abstract**

**Background:**

Surgical robots operations is an emerging technology that offers many advantages in conducting complex endoscopic procedures. However, robot-assisted inguinal hernia repair generates controversies compared to laparoscopic inguinal hernia repair. We evaluated the safety and efficiency of robot-assisted inguinal hernia repair compared to the laparoscopic.

**Methods:**

The Pub Med, EMBASE, and Cochrane Library databases was carried out to obtain studies that comparatively evaluated the efficacy, safety, and the economy between robot-assisted and laparoscopic inguinal hernia repair. Rev man software was used to analyze the data according to random effects models.

**Results:**

Six studies, of 3246 patients were included, 1025 patients underwent robot-assisted and 2221patients underwent laparoscopic surgery. The review showed that robotic-assisted inguinal hernia may reduce the pain compared with laparoscopic, while hospitals cost was significantly higher in robotic surgery than laparoscopic. There was no significant difference between robotic and laparoscopic surgery in decreasing surgical site infection (OR=4.08, 95%CI: 0.39-43.02, P=0.24), hospital length (MD=0.03, 95%CI: 0.04-0.10, P=0.34), the incidence of hematoma (OR=1.38, 95%CI: 0.57-3.37, P=0.48), seroma (OR=1.15, 95%CI: 0.61-2.15, P=0.67), urinary retention (OR=1.42, 95%CI: 0.67-2.97, P=0.36), and complication (OR=1.158, 95%CI:0.87-2.87, P=0.14).

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**Conclusions:**
This study showed robotic-assisted inguinal hernia might reduce pain compared with the laparoscopic group but incurred higher costs. There was no significant difference between robotic and laparoscopic surgery in other efficacy and safety outcomes, which im plying that robotic surgery could be an alternative procedure to laparoscopic instead of replacement in inguinal hernia repair. More robust and high-value randomized trials are required to determine the safety and efficacy of robot-assisted inguinal hernia repair.

**Keywords:** Efficacy and safety of Robotic, Laparoscopic, Inguinal Hernia, A Systematic Review, Meta-analysis.

## Introduction

Preview studies showed that more than 20million patients undergo inguinal hernia repair every year, it was one of the most frequently performed surgical procedures worldwide[1,2]. The risk of developing an inguinal hernia repair was 27–43% for men and 3–6% for women in their life time. In spite of all progress, 11% of all patients endure a recurrence and 10–12% from chronic pain following primary inguinal hernia repair [1,3,4]. Since the first announcement technique for the repair of inguinal hernia was described by E. Bassini in 1887 [5, 6]. Several methods have been developing to repair an inguinal hernia. Presently, a previous study has shown that three techniques have been improve scientifically confirmed and can be suggested for clinical application (surgical procedure)[6,7]. These surgical techniques are open repair without mesh (Should ice technique), open repair with mesh (Lichtenstein technique), and laparoscopic technique [5,6]. Several publications have demonstrated a definite advantage for laparoscopic over open inguinal hernia repair with reduced post-operative pain and earlier return to work and normal activities [8,6,10]. The laparoscopic repair also offers clear advantages in bilateral inguinal hernia and recurrent inguinal hernia repairs [5]. In recent years, a new method called robotic inguinal repair is rising rapidly, and the effects of the surgery were demonstrated in the field of urology [7].

Robotic inguinal hernia repair was initially described in general surgery literature by Dominguez et al in 2015 [5], and subsequently outlined in urologic literature [4]. It has become an alternative method to minimize invasive inguinal hernia repair. Reduced postoperative pain associated with suturing mesh for fixation (as opposed to tack fixation in traditional laparoscopic repair), and improved surgeon ergonomics (body positioning and use of limbs during surgical procedures) are some of the benefits of robotic inguinal hernia surgery [7, 8].
Even with a seemingly rapid adoption of robotic technology for this technique worldwide, to date, no head-to-head systematic review and meta-analysis have been performed comparing laparoscopic and robotic transabdominal preperitoneal (TAP) inguinal hernia repair to investigate relevant outcomes such as postoperative pain, recurrence, cost, and surgeon workload and economics. The systematic review and meta-analysis aim to comprehensively collect all currently available evidence and analyze the efficacy and safety of robotic inguinal versus laparoscopic inguinal hernia repair.

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## Methods

The principles of the Preferred Reporting Items for Systematic Reviews and meta-analyses check list (PRISMA Statement) were used in conducting the systematic review. The present systematic review and meta-analysis was registered at PROSPERO (International prospective register of systematic reviews), the ID was CRD42020198492.

## Literature search

Literature quest was conducted via the following search strategies: Pub Med, Embase and Cochrane Library to identify studies comparing robotic platforms with laparoscopy techniques during in guinal hernia repair procedure. We searched for papers using the following search strategy: ("Robotics [Title/Abstract]" OR "Robotic Surgical Procedures [Title/Abstract]" OR "robotic hernia repair[Title/Abstract]" OR "Robotics[Mesh]") AND ("inguinal hernia/surgery [Mesh]"OR inguinal hernia*[Title/Abstract] OR "inguinal herniarepair[Title/Abstract]" OR "Should ice[Title/Abstract]"). In addition, we checked the references of any related review articles or meta-analysis to find more eligible studies, and all our research was performed in the English language.

## Inclusion and exclusion criteria

Studies were included if they met the following criteria: (a) population: patients were diagnosed with inguinal hernia repair; (b) Intervention: robotic inguinal versus laparoscopic surgery. (c) Out comes: no restriction; (d) Study design: no restriction. The exclusion criteria were as follows: (a) duplicate reports of a study; (b) studies with insufficient data and without the author's response (e.g., protocols, conference proceedings or abstracts, among others)

## Study selection and data extraction

The screening and extraction of data were conducted separately by two independent reviewers. In the event of opposing views between the two reviewers, a third reviewer is invited to reconcile the differences. Duplicate articles were detected and removed using End Note X8 software (Thomson Corporation; Stamford, CT). Subsequently, the reviewers screened the tittles and abstracts of the selected articles. An article is denied further review when it was excluded by both reviewers. Article full text is obtained and examined for suitability when it is only being included by one reviewer, or when the title and abstract do es not provide sufficient information to make a decision. Data general information about the year of publication, the first author's name, trial design, sample size, as well as, the patient characteristics, such as gender, type of disease and mean age were extracted into a predesigned table. The details of the intervention, including the duration and treatment techniques, and the risk of bias and outcomes data were also extracted.

## Quality assessment

The risk of bias of randomized control trials was evaluated using the tool recommended in the Cochrane Handbook Version 5.1.0 (Cochrane Collaboration; London, United Kingdom; Tao et al., 2016) according to seven aspects as follows: random sequence generation, allocation concealment, blinding of participants and personnel, blinding of outcome assessment, incomplete

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outcome data, selective reporting, and other bias. Each item was classified as yes ("low risk of bias"), no ("high risk of bias"), or unclear ("moderate risk of bias"). When the risk of bias of all seven components was defined as "low risk of bias," the trial was defined as the overall "low risk of bias." At the same time, when one or more of the seven bias components was classified as high risk, the trial was graded as "high risk of bias." In other cases, the trial was graded "unclear risk." Disagreements in bias classification were resolved by discussions among the two reviewers and, if necessary, through discussions with the authors.

Non-randomized controlled trials evaluated the risk of bias by the use of the ROBINS-I tool. It is an emerging tool for bias risk assessment specifically for non-randomized intervention trials, which is similar in scope to the Cochrane risk assessment tool. And it covers seven domains through which bias might be introduced into a NRSI (non-randomised studies of interventions). The first two domains are biased due to confounding and bias in the selection of participants into the study, covering confounding and selection participants into the study, addressing issues before the start of the intervention that are to be compared ("baseline").The third domain addresses classification of the interventions themselves. The other four domains address issues after the interventions start: biases due to deviations from intended interventions, missing data, measurement of outcomes, and selection of the reported result [11]. When the study is comparable to a well-performed randomized trial, all domains were low bias, the study is judged to be 'low risk of bias'; When The study provides sound evidence for a non-randomized research but cannot be considered comparable to a well-performed randomized trial, all domains were low or moderate bias, the study is judged to be 'moderate risk of bias'; When the study has some important problems, at least one domain was at serious risk of bias, but not at critical risk of bias in any domain, the study is judged to be of 'serious risk of bias'; When the study is more problematic to provide any helpful evidence and should not be included in any synthesis, at least one domain was at critical risk of bias, the study is judged to be of 'critical risk of bias'; When no information which base a judgment about risk of bias, there is no clear indication that the study is at serious or critical risk of bias.

**Certainty assessment**

To evaluate the certainty (quality) of evidence associated with each outcome, we employed the Grades of Recommendation, Assessment, Development, and Evaluation (GRADE) system [9,10, 12], and subsequently created a table containing the summary of the findings. The GRADE approach was also employed to determine which estimated association or effect represent the evaluated item. The following have been put into consideration in the evaluation of the quality of evidence:1) the quality of the methods used in the study, 2) evidence's veracity, 3) data heterogeneity, 4) the precision in the estimate of the effects, and 5) the risk of publication bias [13]

**Data analysis**

Rev Man version 5.3 (Cochrane Collaboration) was used in conducting the meta-analysis. Variables that are dichotomous were assessed by the use of risk ratio (OR) at a confidence interval of 95% (95% CIs). Mean differences (MDs) were used in analyzing variables that are

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continuous, also at 95% CIs. To generatem eans, standards of continuous variables from studies which were presented in P values, ranges, and medians, statistical algorithms were employed, to pool the studies, a random-effect model was used. Mantel-Haenszel method was used to conduct the meta-analysis on binary variables, while the inverse variance method was used for the continuous variables. The evaluation of heterogeneity was performed using $I^2$ statistics and the Cochran Q test. Studies of low quality were excluded by sensitivity tests.

## Results

### Study selection

A flow diagram of the literature selection process is presented in (Figure1). A total of 543 studies relevant to the search terms were retrieved still, 155 of these were excluded on the basis of duplication, 374 records excluded based on screening of titles or abstracts, of which 360were considered to be not eligible. The full texts of the remaining 14articles were screened for a more accurate estimate, and eight trials were excluded from our analysis. Finally, one RCT and 5Non-RCTs (all in English language) met our inclusion criteria**.**

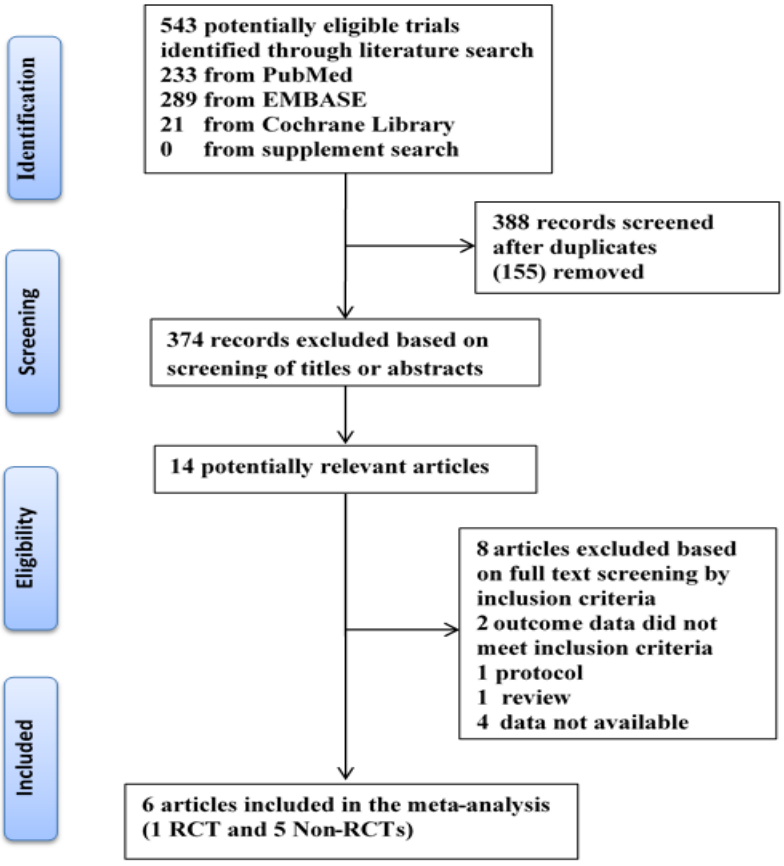


Figure.1 Flow diagram of the literature screening process and results

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**Study characteristics**

Six studies included [13-18] elucidated the outcomes of robotic and laparoscopy with 1025 and 2221patients, respectively were included. The characteristics of studies included in the meta-analysis and Clinicals relevant are shown in (Table1-1),(Table1-2), and (Table1-3). All of the included studies were published between2017-2020 year. Included trials, four trials (60%) were conducted in the United States, and one in Turkey (16.7%), one in France (16.7%). Quality assessment results were shown in (Table 2-1) and (Table 2-2). Table 3 shows the quality of evidence.

Table 1-1 Characteristics of included studies in the meta-analysis

| Author | Country | period | Design | Group | Total | Sex (F%) | Mean Age | BMI (kg\ $m^2$) | Follow up (week) | Operation time |
|---|---|---|---|---|---|---|---|---|---|---|
| Aghayeva [15],2020 | Turkey | 2016-2018 | Retrospective | R-IHR | 43 | 6.9 | 52.1 | 25.5 | 97.6 | 129.1 ± 47.2 |
| | | | | L-IHR | 43 | 6.9 | 52.3 | 25.2 | 92.8 | 92.5 ± 28.3 |
| Khoraki [17],2019 | USA | 2015-2017 | Retrospective | R-IHR | 45 | 0.06 | 49.6 | 27.5 | NA | 116±36 |
| | | | | L-IHR | 138 | 0.036 | 49.6 ± 13.3 | 26.2 | NA | 95±44 |
| Charles [16],2017 | USA | 2012-2016 | Retrospective | R-IHR | 69 | 14.5 | 52 (39–62) | 24.9 | 22 | 105 (76–146) |
| | | | | L-IHR | 241 | 11.2 | 57 (45–67) | 25.8 | 22 | 81 (61–103 |
| LeBlanc [18],2020 | France | 2016-2018 | prospective | R-IHR | 80 | 5 | 58.95 (46.7-68.6) | 27.1 | 2–4 | 92 |
| | | | | L-IHR | 80 | 7.5 | 59.7 (49.5-68.55) | 26.8 | 12 | 68.5 |
| Abdelmoaty [13],2018 | USA | 2015-2017 | Retrospective | R-IHR | 734 | NA | NA | NA | NA | 87 |
| | | | | L-IHR | 1671 | | NA | NA | NA | 56 |
| Prabhu [14],2020 | USA | 2016-2019 | RCT | R-IHR | 54 | 8.4 | 57.2 (13.3) | 26.9 | 4 | 75.5 (59.0-93.8) |
| | | | | L-IHR | 48 | 11.1 | 56.1 (14.1) | 24.9 | 4 | 40.5 (29.2-63.8) |

NA not available, L-IHR laparoscopic Inguinal Hernia Repair, R-LHR Robotic Inguinal Hernia Repair

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Table 1-2 Clinical relevant of included studies in the meta-analysis

| Authors | Group | Total | Superficial surgical site infection, n (%) | Seroma, n(%) | Hematoma, n(%) | Urinary retention | Recurrent hernias, n (%) | length of Hospital | Hospital cost |
|---|---|---|---|---|---|---|---|---|---|
| Aghayeva [15], 2020 | R-IHR | 43 | NA | 5 (11.6) | 0 (0) | 1 (2.3) | 1\43 | 1.4 ± 0.7 | 2275$ |
| | L-IHR | 43 | NA | 4 (9.3) | 0 (0) | 0 (0) | 1\43 | 1.2 ± 0.7 | 1008$ |
| Khoraki [17], 2019 | R-IHR | 45 | 1 (2.2) | 5 (11.1) | 1 (2.2) | 2 (4.4) | 5 (11.1) | 0.13± 0.5 | 9993$ |
| | L-IHR | 138 | 0 (0) | 16 (11.6) | 1 (0.7) | 7 (5.1) | 6 (4.3) | 0.04± 0.25 | 5994 |
| Charles [16], 2017 | R-IHR | 69 | 2.9 (2) 2\69 | NA | NA | 0/69 | 0 (0) | NA | total hospital charges (Robot: $27,017 [$20,993–34,443], |
| | L-IHR | 241 | 0 (0) 0\241 | NA | NA | 0.4 (1) 1\241 | 0 (0) | NA | total hospital charges Lap: $16,016 [$11,444–21,761], hospital cost Lap: $4527 [$2310–6003] |
| LeBlanc [18], 2020 | R-IHR | 80 | 0(0) | 9 | 9 | 11 | 17 (21.25) | NA | NA |
| | L-IHR | 80 | 0(0) | NA | NA | NA | 10 (12.5) | NA | NA |
| Abdelmoaty [13], 2018 | R-IHR | | NA | NA | NA | NA | NA | 0.26 days | -5517 |
| | L-IHR | | NA | NA | NA | NA | NA | 0.25days | 3269$ |
| Prabhu [14], 2020 | R-IHR | 48 | 0% | NA | NA | 2.08 % | NA | NA | $3258 [$2568-$4118] |
| | L-IHR | 54 | 1\54 | NA | NA | 1.85 % | NA | NA | $1421 [$1196-$1930 |

NA not available, L-IHR laparoscopic Inguinal Hernia Repair, R-LHR Robotic Inguinal Hernia Repair

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Table 1-3 Clinical relevant of included studies in the meta-analysis

| Author | Group | Total | Conversion to open, n (%) | Hernia site n (%) | | Readmission | Chronic pain n(%) |
|---|---|---|---|---|---|---|---|
| | | | | Unilateral | bilateral | | |
| Aghayeva [15], 2020 | R-IHR | 43 | NA | 21 (48.8%) | 22 (51.2%) | 0 (0%) | 2 (4.6%) |
| | L-IR | 43 | NA | 21 (48.8%) | 22 (51.2%) | 0 (0%) | 1 (2.3%) |
| Khoraki [17], 2019 | R-IHR | 45 | 0 (0) | NA | 8 (17.8) | 3 (6.7) | NA |
| | L-IHR | 138 | 1 (0.7) | NA | 41 (29.7) | 1 (0.7 | NA |
| Charles [16], 2017 | RAC | 69 | NA | 69 (13.8) | NA | Related: 0 (0) Unrelated 0 (0, | NA |
| | L-IHR | 241 | NA | 241(48.1%) | NA | Related:2.1 (5) Unrelated:0.4 (1) | NA |
| LeBlanc [18], 2020 | R-IHR | 80 | 0 | 42 (52.5) | 38 (47.5) | 0 | |
| | L-IHR | 80 | 1 (1.25) | 46 (57.5) | 34 (42.5) | 0 | 0 |
| Abdelmoaty [13], 2018 | R-IHR | 734 | 0 | 734 | 0 | NA | NA |
| | L-IHR | 1671 | 0 | 1671 | 0 | NA | NA |
| Prabhu [14], 2020 | R-IHR | 54 | 0 | 54 | 0 | NA | NA |
| | L-IHR | 48 | 0 | 48 | 0 | NA | NA |

NA not available, L-IHR laparoscopic Inguinal Hernia Repair, R-LHR Robotic Inguinal Hernia Repair

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Table 2-1 Risk of bias (NRCT)

| Authors | Bias due to confounding | Bias in selection of participants into the study | Bias in classification of intervention | Bias due to missing | Bias in measurement of outcomes | Bias in selection of the report result |
|---|---|---|---|---|---|---|
| Aghayeva [15], 2020 | higher | higher | unclear | higher | unclear | low |
| Khoraki [17], 2019 | higher | low | unclear | low | unclear | unclear |
| Charles [16], 2017 | higher | low | unclear | unclear | unclear | unclear |
| LeBlanc [18], 2020 | higher | low | unclear | higher | unclear | unclear |
| Abdelmoaty [13], 2018 | low | unclear | unclear | unclear | unclear | low |

Table 2-2 Risk of bias (RCT)

| Author | Random sequence generation | Allocation concealment | Blinding of personnel | Blinding of patients | Blinding of Outcome Assessors | Incomplete Outcome Data | Selective Outcome Reporting | Role of the ponsor |
|---|---|---|---|---|---|---|---|---|
| Prabhu [14], 2020 | low | unclear | higher | low | higher | low | low | low |

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Table 3 Summary of findings

**The efficacy and safety of Robotic vs Laparoscopic Inguinal Hernia Repair**

**Patient or population**: Inguinal Hernia Repair patients
**Setting**: Hospital
**Intervention**: Robotic Inguinal Hernia Repair
**Comparison**: Laparoscopic Inguinal Hernia Repair

| Outcomes | Anticipated absolute effects* (95% CI) | | Relative effect (95% CI) | № of participants (studies) | Certainty of the evidence (GRADE) |
|---|---|---|---|---|---|
| | **Risk with Laparoscopic** | **Risk with Robotic surgery** | | | |
| Surgical site infection | 2 per 1,000 | **9 per 1,000** (1 to 91) | **OR 4.08** (0.39 to 43.02) | 595 (3 observational studies) | ⊕⊕◯◯ LOW |
| Hematoma | 38 per 1,000 | **52 per 1,000** (22 to 118) | **OR 1.38** (0.57 to 3.37) | 429 (3 observational studies) | ⊕⊕⊕◯ MODERATE |
| Seroma | 111 per 1,000 | **126 per 1,000** (71 to 212) | **OR 1.15** (0.61 to 2.15) | 429 (3 observational studies) | ⊕⊕⊕◯ MODERATE |
| Urinary retention | 54 per 1,000 | **75 per 1,000** (37 to 145) | **OR 1.42** (0.67 to 2.97) | 531 (4 observational studies) | ⊕⊕⊕◯ MODERATE |
| Patient with any complication | 130 per 1,000 | **191 per 1,000** (115 to 301) | **OR 1.58** (0.87 to 2.87) | 429 (3 observational studies) | ⊕⊕◯◯ LOW |
| length of Hospital (day) | The mean length of Hospital (day) was **0.50** day | MD **0.03 day higher** (0.04 higher to 0.1 higher) | - | 2373 (3 observational studies) | ⊕⊕◯◯ LOW |

*__The risk in the intervention group__ (and its 95% confidence interval) is based on the assumed risk in the comparison group and the **relative effect** of the intervention (and its 95% CI).
**CI:** Confidence interval; **OR:** Odds ratio; **MD:** Mean difference

**GRADE Working Group grades of evidence**
**High certainty:** We are very confident that the true effect lies close to that of the estimate of the effect
**Moderate certainty:** We are moderately confident in the effect estimate: The true effect is likely to be close to the estimate of the effect, but there is a possibility that it is substantially different
**Low certainty:** Our confidence in the effect estimate is limited: The true effect may be substantially different from the estimate of the effect
**Very low certainty:** We have very little confidence in the effect estimate: The true effect is likely to be substantially different from the estimate of effect

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## The results of meta-analyses

### Surgical site infection

Our meta-analysis results demonstrated that there was no significant difference between robotic and laparoscopic surgery in reducing the surgical site infection of inguinal hernia repair patients (Figure2)(OR=4.08, 95%CI: 0.39-43.02,P=0.24). The heterogeneity was observed moderate certainty, $I^2$=40 %, P=0.19**.** Three trials including 595 patients evaluated the surgical site infection of robotic surgery for inguinal hernia repair patients [14,16,17].

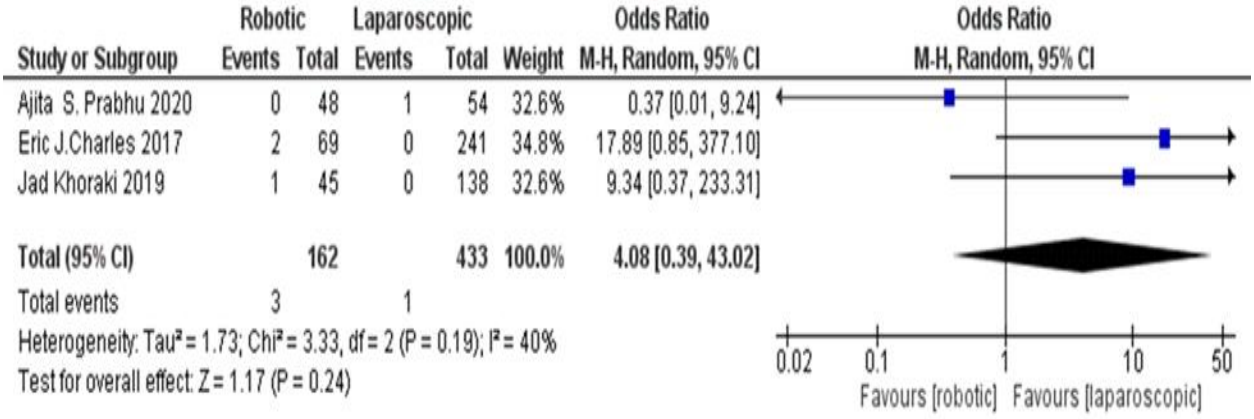


Figure.2 Forest plot of Surgical site infection

### Length of Hospital (day)

In this study our method showed that there was no important difference between robotic and laparoscopic surgery in decreasing the length of hospital for inguinal hernia repair patients (MD=0.03, 95%CI: 0.04-0.10, P=0.34)(Figure3). The heterogeneity was observed low certainty, $I^2$=19%, P=0.29. Three trialsincluding 2373 patients evaluated the length of hospital of robotic surgery in inguinal hernia repair patients [13,15,17].

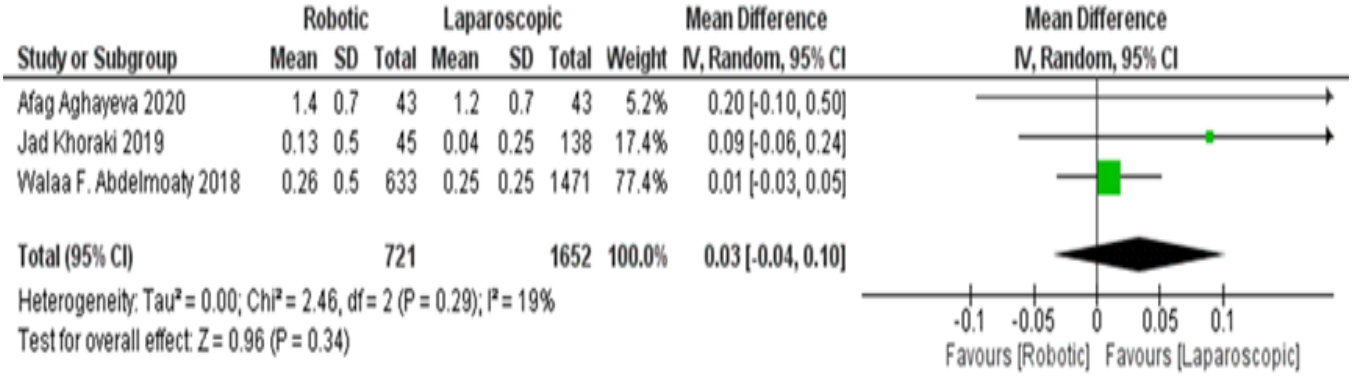


Figure.3 Forest plot of length of hospital (day)

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**Hematoma**

The outcome of hematoma shows that the three trials, including 429 patients, evaluated the incidence of hematoma for surgical robotic [15, 17, 18] as in (Figure4). Our technique results revealed that the difference between robotic and laparoscopic surgery in decreasing the hematoma incidence for inguinal hernia repair patients was not significant (OR=1.38, 95%CI: 0.57-3.37, P=0.48). The heterogeneity was observed low certainty, $I^2$=0%, P=0.55

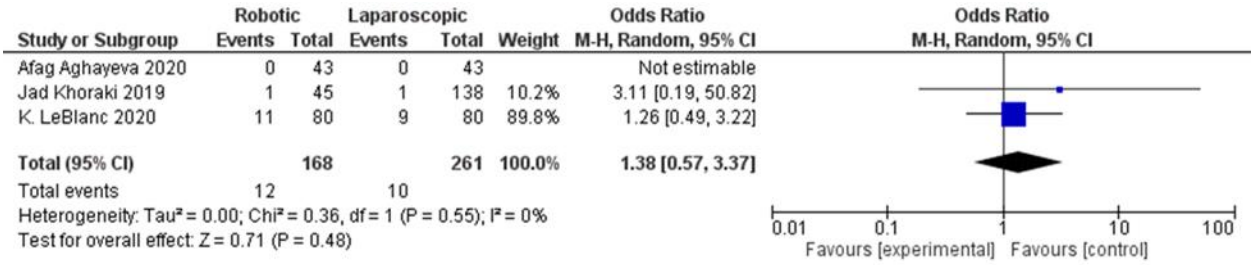


Figure.4 Forest plot of hematoma

**Seroma**

Figure 5 show that the three trialsincluding 429 patients evaluated the incidence of seroma of robotic surgery for inguinal hernia repair patients [15,17,18]. The results of meta-analysis demonstrated that there was no significant difference between robotic and laparoscopic surgery in reducing the accumulation of seroma in inguinal hernia repair patients (OR=1.15, 95%CI: 0.61-2.15, P=0.67). The heterogeneity was observed low certainty, $I^2$=0 %, P=0.91**.**

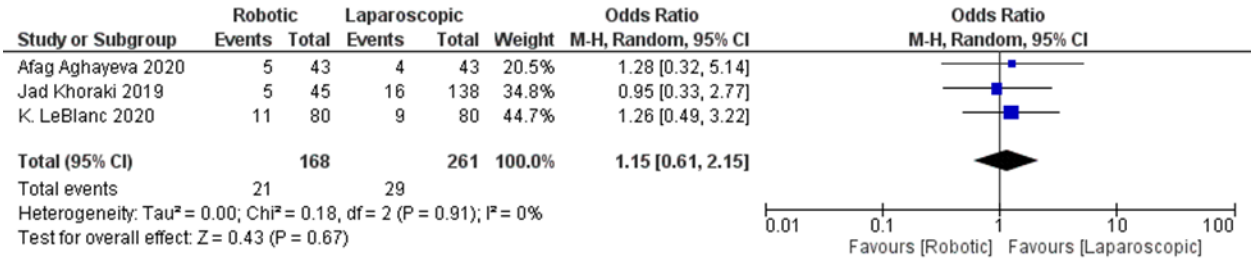


Figure.5 Forest plot of seroma

**Urinary retention**

Four trialscounting 531 patients evaluated the urinary retention of robotic surgery for inguinal hernia repair patients [14,15,17,18] as in (Figure6). Our method results demonstrated that there was no significant difference between robotic and laparoscopic surgery in reducing urinary retention of inguinal hernia repair patient (OR=1.42, 95%CI: 0.67-2.97, P=0.36). The heterogeneity was observed low certainty, $I^2$=0%, P=0.61**.**

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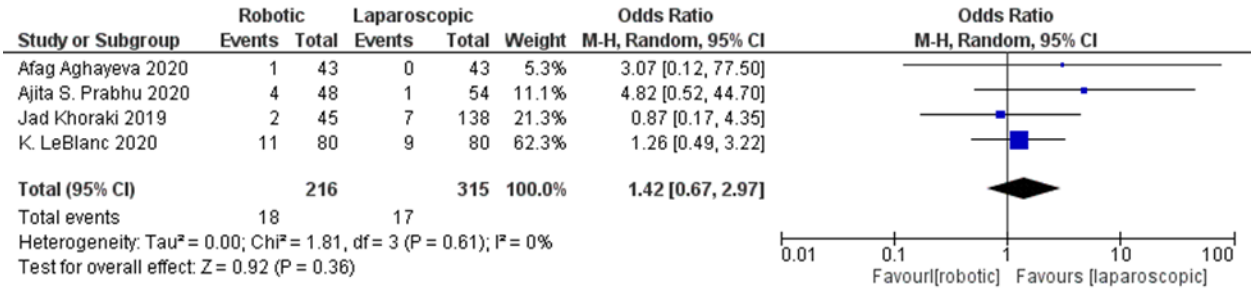


Figure.6 Forest plot of urinary retention

**Patient with complication**

In Figure 7 our technique results demonstrated that there was no significant difference between robotic and laparoscopic surgery in reducing the complication of inguinal hernia repair patients (OR=1.58, 95%CI: 0.87-2.87, P=0.14). The heterogeneity was observed moderate certainty, $I^2$=0 %, P=0.54**.** Three trialsincluding 429 patients evaluated the complication of robotic surgery for inguinal hernia repair patients [15,17,18].

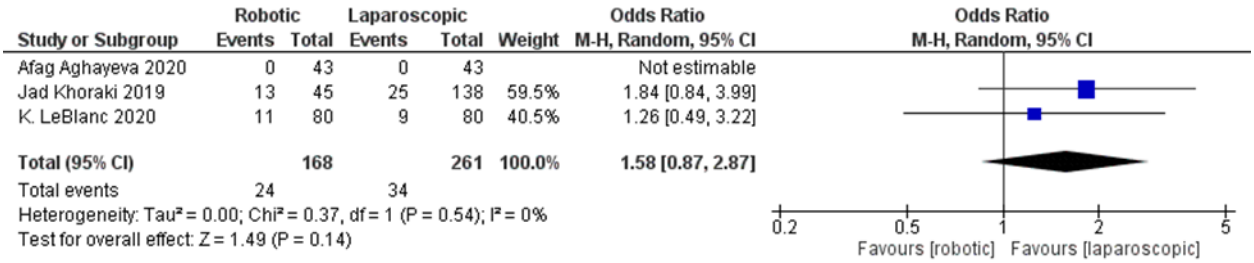


Figure.7 Forest plot with any complication

**Pain**

Three studies addressed pain as a specific outcome, and they all indicated that robotic-assisted inguinal hernia was associated with a reduction in pain compared with the laparoscopic group. One study showed that the number of patients required prescription pain medication was high in laparoscopic compare to robotic-assisted group [51 (65.4%) vs 34 (45.3%), P=0.013] [18]. In another study, the pain was measured by the Visual Analog Scale (VAS)with the score at 24 hours 20.3 ± 18.7 for robotic and 36.87 ±20.1 for a laparoscopic group, P=0.001[15].

**Hospitalization costs**

Four including studies [13,14,15,17] showed that the hospital's cost was significantly higher in robotic surgery than in laparoscopic surgery. Abdelmoaty et al. [13] indicated that the average total cost of the robotic-assisted hernia repair was significantly higher than the laparoscopic repair ($5517 ± $1016 vs $3269 ± $1167; p < 0.001). Similarly, in this study, the total cost was

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divided by fixed cost and variable cost, in which fixed cost included medical device and personnel cost, variable cost included disposables and reusables. As Aghayevaet al.[15] demonstrated that total hospital cost and total disposable supplies cost are the fundings of cost analysis distinctly, the valued cost for the length of hospital, medications, anesthesia and operating room all are total hospital costs with 4778$ for robotic-assisted hernia repair and 3852$ for laparoscopic repair, and the total disposable supplies included medical devices e.g. trocars, fixation devices, robotic instruments et al. by another hand, Prabhu and Khorakimentioned that the costs of robotic-assisted hernia repair versus laparoscopic repair were $3258 ($2568-$4118) vs $1421 ($1196-$1930), P< 0.001and $9993 vs. $5994, p < 0.001, respectively[14, 17].s

**Discussion**

To our knowledge, this review is the first to comprehensively compare outcomes of robotic and laparoscopic approaches to unilateral inguinal hernia repair. We include six published studies involving a total of 3246patients with inguinal hernia repair. Our meta-analysis showed that robotic-assisted inguinal hernia may be associated with a reduction in pain compared with the laparoscopic group, while hospitals cost was significantly higher in robotic surgery than in traditional laparoscopic surgery. There was no significant difference between robotic and laparoscopic surgery in decreasing surgical site infection, the length of hospital, the incidence of hematoma, seroma, urinary retention, and any complication. As shown in (Table 3), the quality of evidence for the reported outcomes was moderate or low. Due to the serious risk of bias; and imprecision of results, we downgraded the quality of evidence by one or two levels. New technologies may be rapidly adopted without supporting evidence to establish their superiority to the existing ones [14]. In spite of the apparently exponential increase in the use of the robotic method in inguinal hernia repair, compared to the static numbers of laparoscopic approaches [19], there is a paucity of comparative literature to support this practice. Studies in support of the robotic method over the laparoscopic method are being hindered by single-group cohorts limited to the quality of life measures, single-surgeon experiences with small patient groups and clinical differences of limited practical or meaningful value [20], multicenter retrospective studies with heterogeneous comparison groups, and extensive administrative database reports lacking in operative granularity and limited in their scope to address salient issues related to hernia recurrence and quality of life [21,22]. A systematic review can provide a comprehensive, unbiased synthesis of evidence [23-26]. In this study, we comprehensively collected evidence on comparative studies assessing the safety, efficacy and economy between robot-assisted and laparoscopic inguinal hernia repair, and we assessed quality of included studies and rated certainty of the evidence. Our meta-analysis showed that robotic-assisted inguinal hernia may be associated with a reduction in pain compared with the laparoscopic group; however, some heterogeneity was found in included studies on the reporting of pain. Different measurement scales and intervention durations may be factors that contribute to these heterogeneities. The different scales vary in the units of measurement for instance, the VAS scale score ranges from 0to 10 points, whereas the VRS scale allows patients to say what they feel, the verbal description score. Therefore, data were not pooled using meta-analysis, we have only described the basic

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features and conclusions of the included studies. Consequently, more high-quality evidence is needed to confirm this conclusion in the future.

However, laparoscopic technique has been demonstrated to decrease postoperative pain and ameliorate recovery when providing treatment for bilateral and recurrent inguinal hernia [27-29] although cannot offer more significant perioperative effects and Low recurrence rates for the cases of primary unilateral hernia.[30-33].

Decision-making in the area of healthcare reform require the consideration of the cost associated with adopting new surgical technology [13]. Allocation of resources should be for achieving maximum benefit regardless of the method, rather than allocating the resource on expensive technology that has no clear benefit. Expenses associated with surgical technologies are important measure in surgical care as they engulfed substantial part of the "limited" healthcare budget. Therefore, novel technology needs to be practically "cost effective" before being embraced by the healthcare systems [13]. Robotic-assisted surgery was designed provide reliable solution to the limitations of laparoscopic surgery [27]. This study demonstrates that the total cost of the robotic-assisted in guinalhernia repair is significantly higher compared to the laparoscopic approach.

The use of robots in the inguinal hernia repair could be a waste of precious resource except it could be justified by a validated improvement in outcome, or the cost associated with robotic surgical system is significantly reduced. Health decision-makers should consider carefully in their decision-making process. The potencies of this meta-analysis are as follows: (1) detail extraction of available data with a larger sample size that made the study comprehensive; (2) application of rigorous and systematic approach that enhanced the quality of the meta-analysis; (3) all related studies were comprehensively collated and extracted; GRADE was employed to evaluate the quality of evidence, and we reported the results of the extracted outcomes comprehensively. The limitations of the meta-analysis that must be taken into consideration are as follows: (1) the selected studies were mostly observational, which made the result interpretation challenging; and (2) blinding assessment of outcomes was rarely conducted; changes should be made ad more attention should be paid to blinding of assessors.

## Conclusions

Our meta-analysis showed that robotic-assisted inguinal hernia might be associated with a reduction in pain compared with the laparoscopic group, while hospitals cost was significantly higher in robotic surgery than traditional laparoscopic surgery. Our results found low, moderate certainty evidence, and there was no significant difference between robotic and laparoscopic surgery in other efficacy and safety outcomes. More high-quality randomized trials are needed to determine the safety and efficacy of robot-assisted inguinal hernia repair.

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Taslim Aboudou and Meixuan Li contributed equally to this work as co-first authors.

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