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ARTICLE

The safety and feasibility of simultaneous robotic repair of an inguinal hernia during robotic-assisted laparoscopic prostatectomy: a systematic review and meta-analysis

Motaz Melhem[a], Javid Burki[a], Omar Algurabi[a], Sayed Gilani[a], Faisal Ghumman[a], Matin Sheriff[a], Mudassir Wani[b], Ra'ed Haddad[c] and Sanjeev Madaan[d,e]

[a]Department of Urology, Medway Maritime Hospital, Kent, United Kingdom; [b]Department of Urology Glangwili Hospital, Wales, United Kingdom; [c]Department of Urology, Oxford University Hospitals, Oxford, United Kingdom; [d]Department of Urology and Nephrology, Darent Valley Hospital, Dartford, United Kingdom; [e]Institute of Medical Sciences, Canterbury Christchurch University, Canterbury, United Kingdom

ABSTRACT

Purpose: This study intended to assess the safety and feasibility of performing concurrent robotic-assisted laparoscopic prostatectomy (RALP) and robotic inguinal hernia repair (RIHR).

Method: We systematically searched the PubMed, Embase and Cochrane Library database up to the year 2020 to identify studies that assessed patients who underwent RALP and RIHR in the same settings.

Results: Thirteen studies were considered suitable for a systematic review and seven for Meta-analysis. RALP and RIHR were associated with significantly longer operative time. RIHR added on average 26 min to the operation time (8, 45 95% CI, $p = 0.005$, I^2 97%). Concurrent RALP and RIHR was not associated with a higher incidence of blood loss (−13, 6 95% CI, $p = 0.43$, I^2 18%), length of stay (−0.08, 0.06 95% CI, $p = 0.73$, I^2 0%) or early postoperative complications.

Conclusion: Concurrent robotic repair of an inguinal hernia during RALP appears feasible and safe. Urologists should be encouraged to repair hernias encountered during RALP keeping in mind possible complications including wound infection, mesh infection, chronic inguinal pain and recurrence of hernia.

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Robotic prostatectomy; radical prostatectomy; RALP and hernia

Introduction

Prostate cancer is the second most common cancer in men [1]. Surgery in the form of radical prostatectomy is one of the primary forms of localised prostate cancer treatment. Presently, in most developed countries, radical prostatectomy is performed through robotic approach [2]. Both clinical and subclinical inguinal hernias are common in the age group of men diagnosed with prostate cancer. During robotic-assisted laparoscopic prostatectomy (RALP) achieving pneumoperitoneum would increase intraabdominal pressure; hence, unrecognised inguinal hernias may become recognised. Facing an inguinal hernia during RALP could be a challenge for the surgeon, whether to repair it or not. Conceptually, a foreign body(mesh) near the urethrovesical anastomosis can act as a nidus for infection and adhesions if the anastomosis leaks and repair would also increase the operative time. Nevertheless, if left untreated subclinical inguinal hernias may manifest themselves clinically within two years of radical prostatectomy [3]. Additionally, repairing at this stage will be associated with longer operative times and increased morbidity due to significant scarring of the pre-peritoneal space from previous RALP. Also, untreated Inguinal hernias may lead to bowel obstruction and/or strangulation, requiring emergency open surgery [4]. The aim of this systematic review is to evaluate the safety and feasibility of simultaneous RALP and robotic inguinal hernia repair (RIHR).

Materials and methods

Protocol and registration

This review was registered in PROSPERO (CRD42021197029). The meta-analysis was reported according to PRISMA (Preferred Reporting Items for Systematic reviews and Meta-Analysis [5]. For the narrative synthesis component of the review, the synthesis without meta-analysis (SwiM) reporting was used [6].

Study eligibility and inclusion criteria

The eligibility of each study was evaluated using the PICO format (i.e. participants, intervention, comparison, outcomes) [5]. The study population was defined as men with prostate cancer undergoing RALP in whom inguinal hernia was robotically repaired in the same settings. RIHR corresponded to the intervention; the comparator was RALP without RIHR.

CONTACT Sanjeev Madaan sanjeev.madaan@nhs.net Department of Urology and Nephrology, Darent Valley Hospital, Canterbury Christchurch University, Dartford, 0000-0003-4220-5613, UK

The main outcome was the safety and feasibility measured by the estimated blood loss (EBL), length of stay (LOS), early postoperative complications and added operative time.

The inclusion criteria regarding study design were any article describing simultaneous RALP and RIHR, including randomised controlled trials, non-randomised trials of interventions, cohort, and case-control studies. The exclusion criteria were review articles, editorials, letters to editors, case reports, and studies not written in English.

Search strategy

A comprehensive computer literature search of PubMed, Embase and Cochrane Library databases up to December 2020 was achieved. The search terms used included 'Robotic Prostatectomy', 'Radical Prostatectomy', 'RALP,' and 'hernia'. A total of 300 articles were found after eliminating duplicates. Two reviewers (MM, JB) independently extracted and reviewed the data based on inclusion criteria, and any inconsistency was resolved by a third senior clinician (SM) to reach a consensus.

Data extraction

The extracted data included first author, year of publication, study design, number of patients who had hernia repair during RALP and control groups, number of surgeons who performed RALP and hernia repair, Baseline characteristics of the study population, type of hernia repair, operative time, added operative time, estimated blood loss, complications related to hernia repair, length of hospital stay, follow-up duration and hernia recurrence.

Assessment of study quality

The quality of the included studies in the meta-analysis part of this review was evaluated according to the Newcastle–Ottawa Scale (NOS) [7]. The three major assessment categories of NOS are selection, comparability, and exposure. A study can be granted up to nine stars, and we categorised study quality as good ($\geq$7 points), fair (5−6 points) and poor ($<$5 points).

Statistical methods

Meta-analysis methods were used to pool the results from the different studies to give a single estimate of the differences in outcome between groups. All analyses were performed using the DerSimonian-Laird random-effects method, regardless of the amount of heterogeneity between studies. The amount of heterogeneity between studies was assessed based on the significance of the between-study heterogeneity, and also on the size of the I^2 value. Substantial heterogeneity was assumed if the I^2 value was above 50%.

The outcomes were a mixture of continuous and binary outcomes. In the individual papers, results for the continuous variables were expressed using different summary statistics. Where only the median value was reported, the mean was assumed to be equivalent to the median. Where the interquartile range was reported, this was assumed to equate to 1.35 standard deviations, and the standard deviation was calculated accordingly. When only the data range was given as a measure of variation, the standard deviation was assumed to be a quarter of the range.

The pooled outcomes for the continuous variables were expressed as the mean difference in outcome between groups, whilst the differences between groups for the binary outcomes were expressed as relative risks.

Results

Search results

A PRISMA flow diagram summing the data is shown in Figure 1. We identified a total of 753 studies, of which 300 remained after removing duplicates. Of these, 287 were excluded according to the selection criteria. Consequently, we interpreted the remaining 13 articles' full text to ensure they match the inclusion criteria, all the 13 studies were included in the systematic review. Out of these, seven studies were comparative and considered suitable for meta-analysis.

Quality assessment and risk of bias and statistical analysis

The results of the quality assessment of the included studies according to the NOS are shown in the Table 1. There were seven cohort studies, and they had a median risk of bias of 8 stars (range 6–9) according to the NOS.

Characteristics of eligible studies

The detailed information of all the seven studies included in meta-analysis is shown in Table 2. The detailed information of remaining six studies included in narrative synthesis is shown in Table 3.

Meta-analysis results

Meta-analysis was performed to compare the outcomes of patients who did and did not have a hernia repair. The meta-analysis results are summarised in Table 4. The first figures (in the second column) are the number of studies that reported suitable data for inclusion in the data analysis. Subsequently, details of the heterogeneity both in terms of the significance and the I^2 value are reported. The final columns give the pooled treatment differences (treatment effect). The top half of the table shows the results for the continuous outcomes. Here, the mean difference in outcome between groups is shown, along with a corresponding confidence interval. This is calculated as value for the repair group minus the value for the no repair group. The results for the one binary outcome are shown in the bottom half of the table. Here, the differences in outcome between groups is expressed as relative risks, reported with corresponding

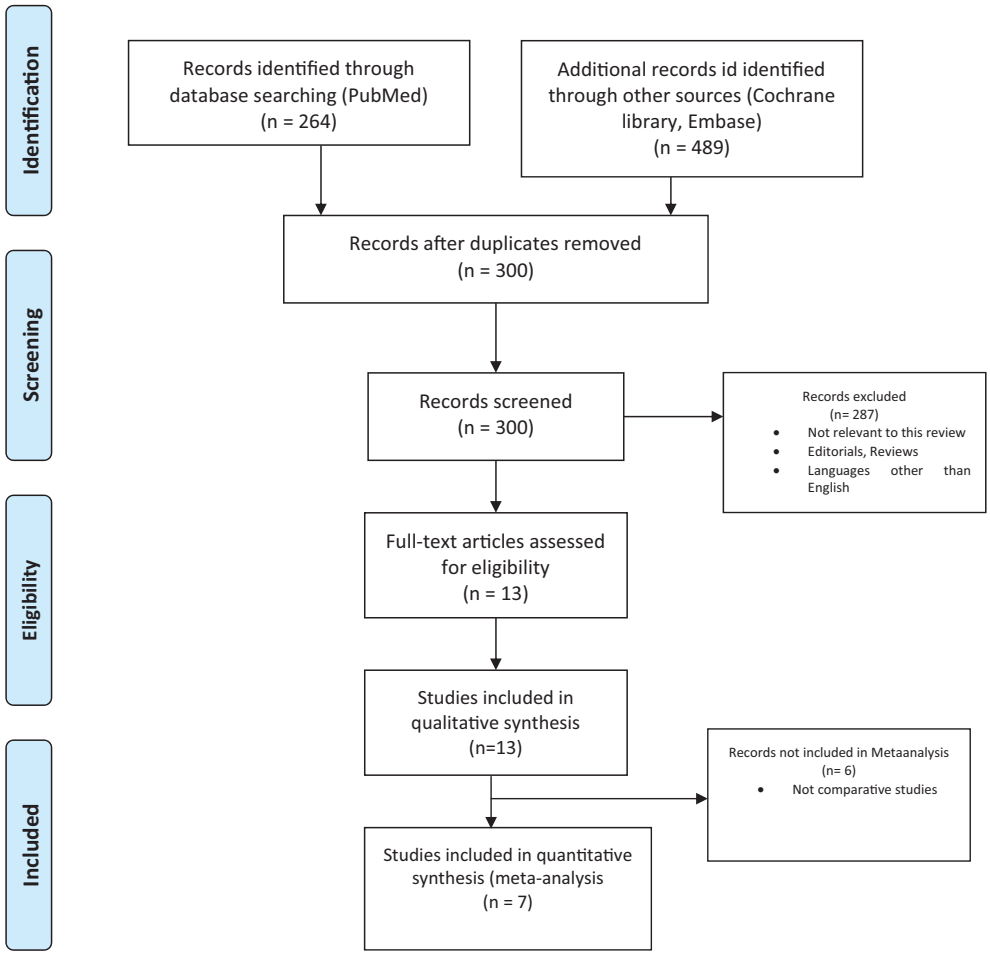

Figure 1. The Preferred Reporting Items for Systematic Reviews and Meta-analyses (PRISMA) flow chart for study selection.

Table 1. Results of quality assessment according to Newcastle–Ottawa Scale.

Author	Selection 1	Selection2	Selection 3	Selection 4	Comparability A	Comparability B	Exposure 1	Exposure 2	Exposure 3	scores
Lee et al.	0	1	1	1	1	1	1	0	0	6
Mourmouris et al.	0	1	1	1	1	1	1	1	1	8
Ludwig et al.	0	1	1	1	1	1	1	1	1	8
Rogers et al.	0	1	1	1	1	1	1	0	1	7
Bajpai et al.	0	1	1	1	1	1	1	1	1	8
Xia et al.	1	1	1	1	1	1	1	0	0	7
Nakamura et al.	1	1	1	1	1	1	1	1	1	9

confidence intervals. This represents the probability of the outcome occurring in repair group relative to the probability in the no repair group. P-values indicating the significance of the difference between groups are also reported.

The results suggested that for two of the outcomes, blood loss and length of stay, there was relatively little heterogeneity between studies. However, for operative time and complications there was considerable heterogeneity between the studies. For these two outcomes, the I^2 values were over 50%, and the test of heterogeneity was either significant or of borderline statistical significance.

There was a significant difference in operative time between groups. This was significantly longer in the repair group, on average 26 min longer than the no repair group (95% confidence interval: 8 to 45 min). There was no significant difference between groups for the blood loss, length of stay or the occurrence of complications.

Graphical illustrations of the individual study results, along with pooled differences are shown in for each individual analysis in the Forest plots in Figures 2–5.

Added operative time

All studies reported added operative time. Five studies with 20,668 patients were included in the meta-analysis. There was a significant difference in operative time between groups. This was significantly longer in the repair group (range 16–68 min), on average 26 min longer than the no repair group (8, 45 95%CI, $p = 0.005$, I^2 97%).

Eight studies were included in a narrative synthesis and showed that operative time spent on hernia repair after completion of RALP ranging between 5–27 min. Ludwig et al. [11]

Table 2. Characteristics of included studies in the meta-analysis.

Study TYPE, YEAR	Group	# SUR	N	Median or mean Age(years)	Mean BMI (Kg/m^2)	SMOKING (CURRENT AND EX)	Median or mean OP TIME (min)	ADDED TIME (min)	BLOOD LOSS (ml)	repair	STAY (days)	COMPLICATIONS	RECURRENCE	FOLLOW-UP (months)
Nakamura et al. [8]	RALP + IHR	6	5	65 (mean)	30 (mean)	NA	NA	31.6(mean)	120(mean)	Non mesh	1.6(mean)	NA	0	Not specified
Retrospective	CONTROL		40	63.9 (mean)	28.3 (mean)	NA	179.5(mean)		132.5(mean)	(1 mesh)	1.8(mean)	NA		
2011														
Lee et al. [9]	RALP + IHR	1	91	62.9 (mean), 6.3(SD)	27.5(mean) ,3.5(SD)	NA	185(mean), 28(SD)	16 (mean)	170(mean), 61(SD)	MESH	1(median)	1	1	9
|Retrospective														
2013	CONTROL		91	62.8(mean), 6.2(SD)	27.8(mean) ,3.1(SD)	NA	168(mean), 31(SD)		194(mean) ,82(SD)		1(median)	2		
Mourmouris et al. [10]	RALP + IHR	1	29	62.82(mean), 5.12(SD)	26.47(mean) ,2.4(SD)	NA	146.6(mean) ,39.4(SD)	4 (mean)	175.86 ± 110.5	NON-MESH	4.34(mean) ,1.3(SD)	0	0	32.1(mean) ,21.1(SD)
Retrospective														
2016	CONTROL		29	61.96(mean), 5.92(SD)	26.44(mean) ,2.46(SD)	NA	143.31(mean) ,54.8(SD)		200 ± 144.5		4.61(mean) ,1.4(SD)	0		
Ludwig et al. [11]	RALP + IHR	1	11	62.4(mean), 8.6(SD)	27.6(mean) ,2.4 (SD)	NA	NA	80 (Bilateral)	209.1(mean) ,76.9(SD)	Mesh	1.4(mean) ,0.5(SD)	1	0	33(mean)
Retrospective														
2016	CONTROL		22	58.6(mean), 8.3(SD)	28.5(mean) ,5.7 (SD)	NA	NA	32(unilateral)	202.4(mean) ,55.8(SD)		1.4(mean) ,0.5	1		
Rogers et al. [12]	RALP + IHR	2	39	62.87(mean)	26.8(mean)	10	188.31(mean)	68(mean)	123.1(mean)	Mesh	1	4	NA	1
Retrospective	CONTROL		1100	61.61(mean)	28.32(mean)	288	120.69(mean)		120.69(mean)		1	57		
2017														
Xia et al. [13]	RALP + IHR	NA	375	64(median)	Not recorded	40	229(median)		NA	NA	1	15	NA	1(median)
Retrospective	CONTROL		17,690	63(median)		2177	195(median)	34(mean)	NA		1	851		
2018														
Bajpai et al. [14]	RALP + IHR	1	143	63.73(mean), 5.3(SD)	26.4(mean) ,4.4 (SD)	8	75.4(mean) ,9.5(SD)	NA	75.4(mean) ,9.5	Mesh	NA	8 in both groups, not significant,	0	36(mean) ,1.4
Retrospective														
2019	CONTROL		1081	62.3(mean), 5.5(SD)	26(mean) ,4.6(SD)	29	67.4(mean) ,11.5(SD)		76.7(mean) ,18.2		NA	CD 1		

Table 3. Characteristics of included studies in the narrative synthesis.

Study TYPE, YEAR	Group	# SUR	N	AGE	BMI	SMOKING (CURRENT AND EX)	OP TIME (min)	ADDED TIME (min)	BLOOD LOSS (ml)	repair	STAY (days)	COMPLICATIONS	RECURRENCE	FOLLOW-UP (months)
Finley et al. [15]	RALP + IHR	1	40	62.4(avg)	26.8(avg)	19	NA	>10	91.5(avg)	Mesh	1.11(median)	1	1	15(median)
RETROSPECTIVE	CONTROL		40	62.49avg)	26.6(avg)	16	NA		104.6(avg)		1.09(median)	NA		
2007														
Finely et al. [16]	RALP + IHR	2	80	62.2(avg)	26.6(avg)	NA	NA	15(avg)	NA	Mesh 2(sutures only)	1.16(avg)	1	1	12.5(avg)
Retrospective														
2008	CONTROL		NA	NA	NA	NA	NA		NA	NA	NA	NA		
Joshi et al. [17]	RALP + IHR	2	4	60.25(mean)	NA	NA	NA	20(mean)	NA	Mesh	2(mean)	0	0	33(mean)
Retrospective	CONTROL		NA	NA	NA	NA	NA							
2010														
Kyle et al. [18]	RALP + IHR	1	37	62.9	27.1	NA	NA	5-10	NA	Mesh	NA	NA	1	29
Retrospective	CONTROL		NA	NA	NA	NA	NA		NA			NA		
2010														
Qazi et al. [19]	RALP + IHR	2	12	66(median)	NA	NA	131(median)	12(avg)	250(median)	Mesh	NA	0	0	12
Retrospective	CONTROL		NA	NA	NA	NA	NA		NA		NA	NA		
2015														
Atmaca et al. [20]	RALP + IHR	2	20	66(mean) ,8(SD)	NA	NA	139(mean) ,21(SD)	27(mean) ,5(SD)	108(MEAN) ,76(SD)	Mesh	4(MEAN) ,0.9(SD)	1	0	13
Retrospective														
2018	CONTROL		NA	NA	Na	NA	NA		NA					

Table 4. Summary of meta-analysis results.

Outcome	Number studies	Heterogeneity		Treatment effect	
		p-value	I^2	Mean (95% CI) (+)	*P*-value
Operative time	5	<0.001	97%	26 (8, 45)	**0.005**
Blood loss	6	0.30	18%	−4 (−13, 6)	0.43
Length of stay	5	0.64	0%	−0.01 (−0.08, 0.06)	0.73

Outcome	Number studies	Heterogeneity		Treatment effect	
		p-value	I^2	RR (95% CI) (++)	P-value
Complications (*)	5	0.05	59%	1.39 (0.58, 3.29)	0.46

(*) One additional study reporting no complications either group excluded from the analysis.
(+) Mean difference reported as outcome in Repair group minus outcome in No Repair group.
(++) Relative risk reported as outcome in Repair group relative to outcome in No Repair group.

mentioned additional operative time for unilateral and bilateral repairs separately, 37 and 80 min, respectively.

Blood loss

Nine studies reported the amount of blood loss. Six of these were included in the quantitative analysis with 2,681 patients. There was no significant difference between groups for the blood loss with mean difference of −4ml (−13, 6 95% CI, $p = 0.43$, I^2 18%).

In the narrative synthesis, three out of six cohort studies reported blood loss and it was ranging from 91.5 mls to 250 mls.

Length of stay

Ten studies reported length of stay, of which six were included in the quantitative synthesis with 18,201 patients. There was no significant difference between the two groups in the duration of stay with mean difference of −0.01 day (−0.08, 0.06 95% CI, $p = 0.73$, I^2 0%).

Four out of Six cohort studies in narrative synthesis reported LOS ranging between 1 and 4 days.

Complications

Ten studies reported postoperative complications. Five were included in quantitative synthesis with 20,641 patients. There was no significant difference between groups for the occurrence of complications with RR 1.39 (0.58, 3.29 95% CI, $p = 0.46$, I^2 59%). Bajpai et al. [14] reported overall eight postoperative complications. However, all were Clavien Dindo class 1 events not necessitating readmission.

Five out of six studies included in a narrative synthesis showed complications in the early post-operative period in three patients, two of which had postoperative urine leak and one patient developed wound evisceration at the camera port place which was extended to retrieve the specimen.

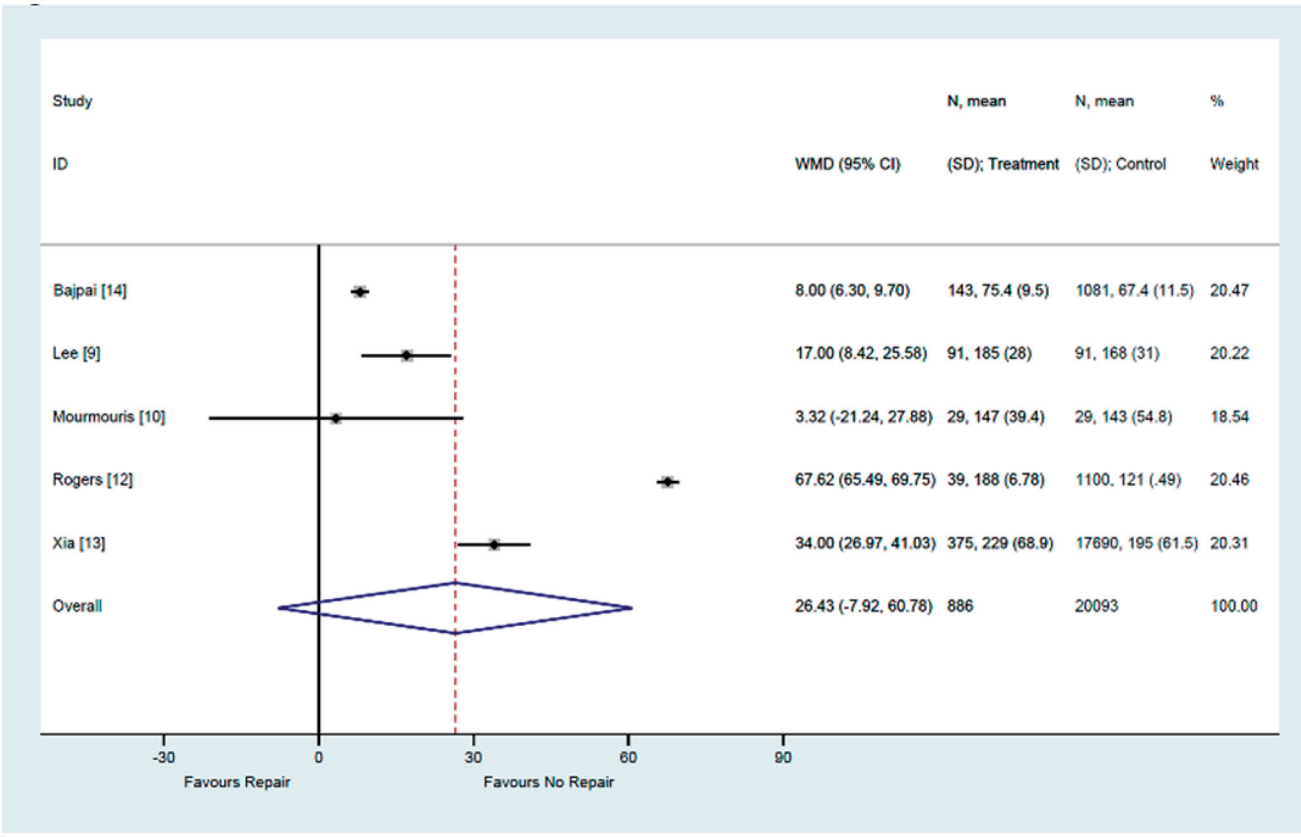

Figure 2. Forest plot for operative time.

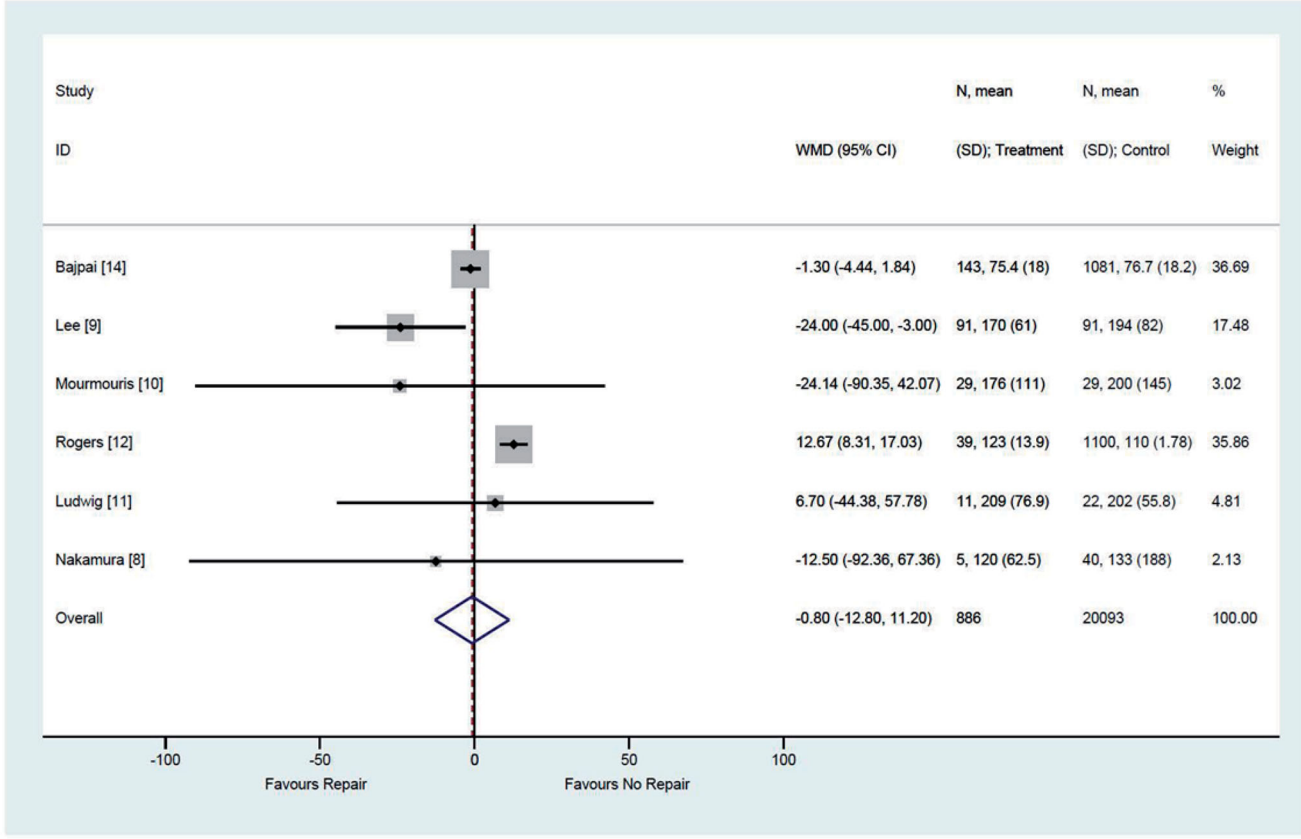

Figure 3. Forest plot for blood loss.

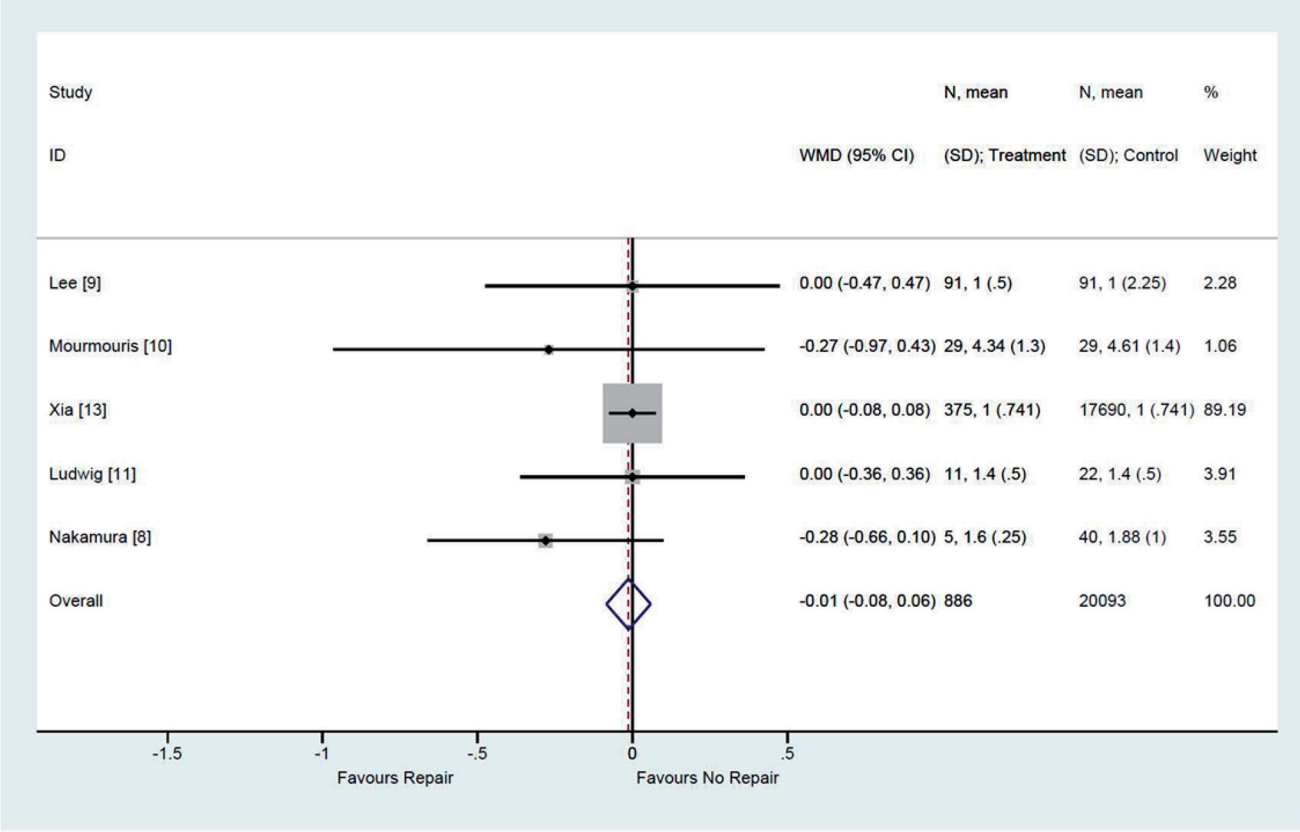

Figure 4. Forest plot for length of stay.

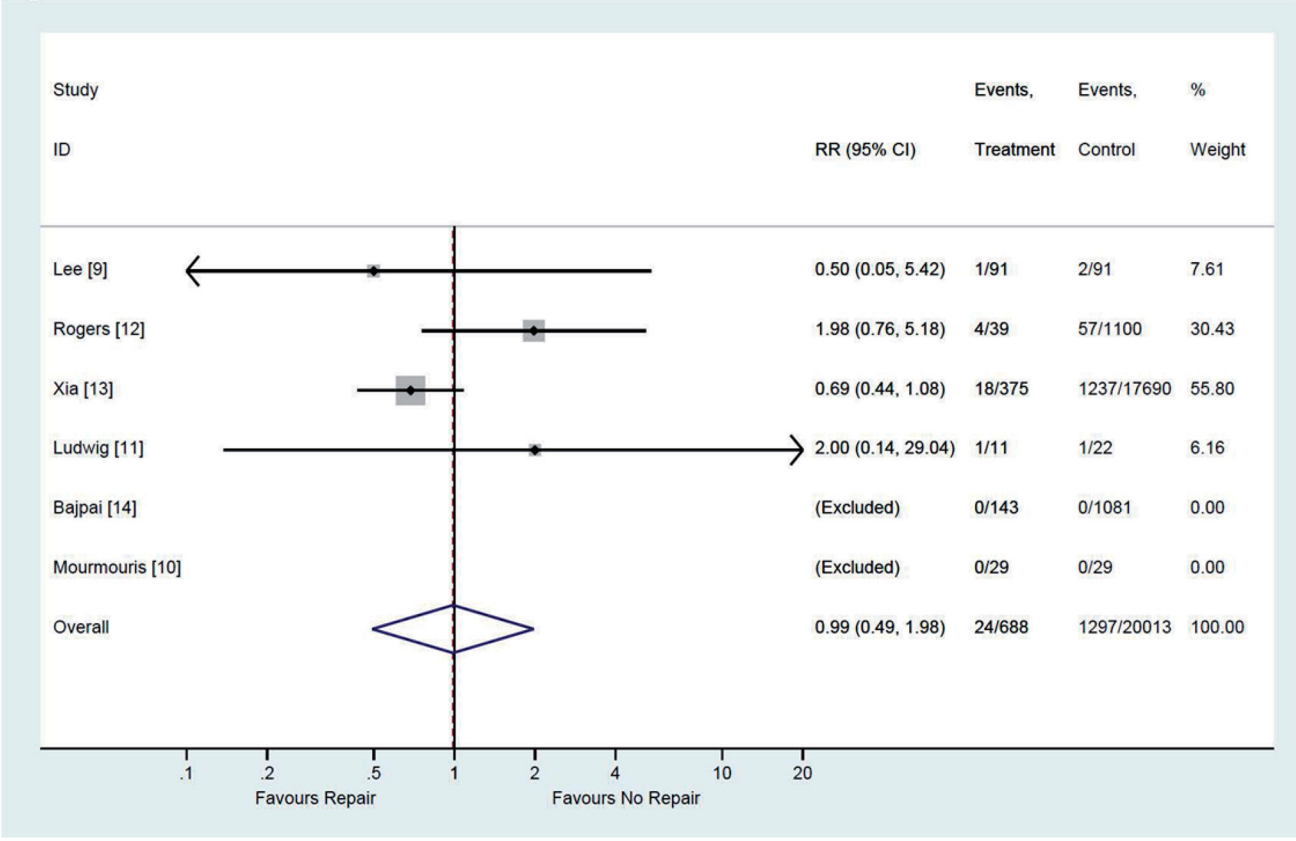

Figure 5. Forest plot for complications.

Hernia recurrence

Total 11 studies assessed hernia recurrence during follow-up period, range (12–50 months). Seven studies reported no recurrence of hernia. Four studies reported one hernia recurrence each in their series.

Discussion

Radical prostatectomy is one of the treatment options for localised prostate cancer. RALP has become the favoured surgical approach in developed countries as this has shown better peri and postoperative complications than open and laparoscopic approaches [21] with no difference in oncological outcomes [22,23]. The risk of finding inguinal hernia during prostatectomy has been reported in up to 33% of prostatectomy patients [24]. Left untreated inguinal hernia may manifest with pain, intestinal obstruction, or strangulation requiring prompt intervention in the postoperative period. Moreover, it might be more difficult to repair it *via* laparoscopic or robotic surgery due to scarring and obliteration of the preperitoneal space in the following months after the previous RALP procedure. Hernia faced during RALP can be repaired either using a mesh to cover the defect in the abdominal wall or reconstruction of posterior abdominal wall. Maourmouris et al. [10] used non-mesh based darn repair, and the final reinforcement of the floor was anticipated to ensue by the secondary fibrotic tissue. In their series none of the patients developed hernia recurrence during a 37.5-month period of follow-up. The technique of repair did not make a difference to the outcomes including recurrence risk.

Mesh infection is a significant concern. Another concern with mesh is the possible risk of bowel adhesions. In the publication by Bajpai et al. [14], 143 patients had a concurrent IHR using 3Dmax^{TM} polypropylene monofilament mesh with no significant complications related to mesh application.

The prevalence of inguinal hernia during RALP range from 3% to 19.4% [25]. Left untreated these subclinical hernias are known to manifest themselves clinically within two years of RALP [3]. Repairing inguinal hernias at time of RALP will spare the patient additional operation. However, the possibility of chronic inguinal pain and other complications like wound infection, mesh infection, ischemic orchitis and hernia recurrence should be kept in mind especially in patients with subclinical hernias discovered incidentally. In our meta-analysis, the total number of hernias repair was 905, of which 179 hernias were detected preoperatively, 291 hernias were subclinical and detected intraoperatively while for 435 cases the authors did not mention whether the hernias were clinical or subclinical. The pros and cons of inguinal hernia repair during RALP should be discussed with the patient before carrying out the procedure.

The risk of hernia recurrence after repair is rare in the present study. Only four recurrences of repaired hernias were detected in a follow-up period of up to 29 months which needed further hernia repair. The method of detection of recurrence is not clarified in all studies, although whenever mentioned physical examination was the method of detection. One recurrence happened soon after surgery, one happened at four months post-surgery and the remaining two recurrences detected within 12 months follow-up.

In the current meta-analysis, operation times were longer (mean additional time of 26 min) when RIHR was performed. The added operative time varied between studies with the longest time of additional 68 min was reported by Rogers et al. [12]. They attributed this long added operative time to the fact that general surgeon performing the hernia repair is not always immediately available. When the same surgeon performed RALP + RIHR, the added operative time was reasonable. Therefore, it may be helpful for the urologist performing RALP to become familiar with the technique of RIHR.

R Bertolo et al. [16] recently published a narrative review concluding that one-stage combined hernia repair and radical prostatectomy (open, laparoscopic, and robot-assisted) may be accepted except in cases of lymph-nodes dissection and/or possibility of anastomotic leak at the urethro-vesical anastomosis.

This systematic review identified a number of limitations in the published data. The major limitation was that all the included studies were retrospective in nature. Many of the included studies are under-powered to exclude significant complications of simultaneous RALP and RIHR, that is, wound infection, Mesh infection, chronic inguinal pain, ischaemic orchitis and hernia recurrence.

Keeping the limitations of our analysis in mind, the results of our meta-analysis do support that performing RIHR at the time of RALP is safe and feasible as it does not increase the estimated blood loss, length of stay or early postoperative complications, without much added time compared to RALP alone. We found a low incidence of inguinal hernia recurrence after repair. These results have to be considered when designing additional prospective studies on this topic.

Conclusion

The current meta-analysis and systematic review showed that concurrent repair of an inguinal hernia during RALP appears feasible and safe regardless of the technique of choice whether mesh or non-mesh repair with minimal added operative time. However, serious complications such as mesh infection should always be kept in mind when performing RALP ± RIHR. A more appropriate larger sample sizes and longer-duration high-quality randomized clinical trials are needed to improve the accuracy of results.

Disclosure statement

No potential conflict of interest was reported by the author(s).

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