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Comparative Efficacy of Cryoablation versus Robot-assisted Partial Nephrectomy in the Treatment of cT1 Renal tumours: A Systematic Review and Meta-Analysis

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SYSTEMATIC REVIEW Open Access

Comparative efficacy of cryoablation versus robot-assisted partial nephrectomy in the treatment of cT1 renal tumors: a systematic review and meta-analysis

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Background and Aim

Background:

- Kidney cancer incidence is rising globally.
- Early diagnosis of small renal masses (<7 cm) is common.
- RAPN is the gold standard, but CA is emerging for high-risk patients.

Aims

- Compare perioperative outcomes (hospital stay, blood loss, complications).
- Evaluate renal function preservation.
- Assess oncologic outcomes (recurrence, survival).

Methods

- **Study Design:**
  - Systematic review & Meta-analysis.
  - 10 studies (2,011 patients: 1,029 CA, 982 RAPN).
- **Data Sources:** PubMed, Embase, Web of Science, Cochrane Library.
- **Outcomes:**
  - Primary: Perioperative results, complications, renal function, recurrence/survival.
  - Secondary: Operative time, Clavien-Dindo complications.
- **Analysis:** Review Manager 5.4; random/fixed-effect models.

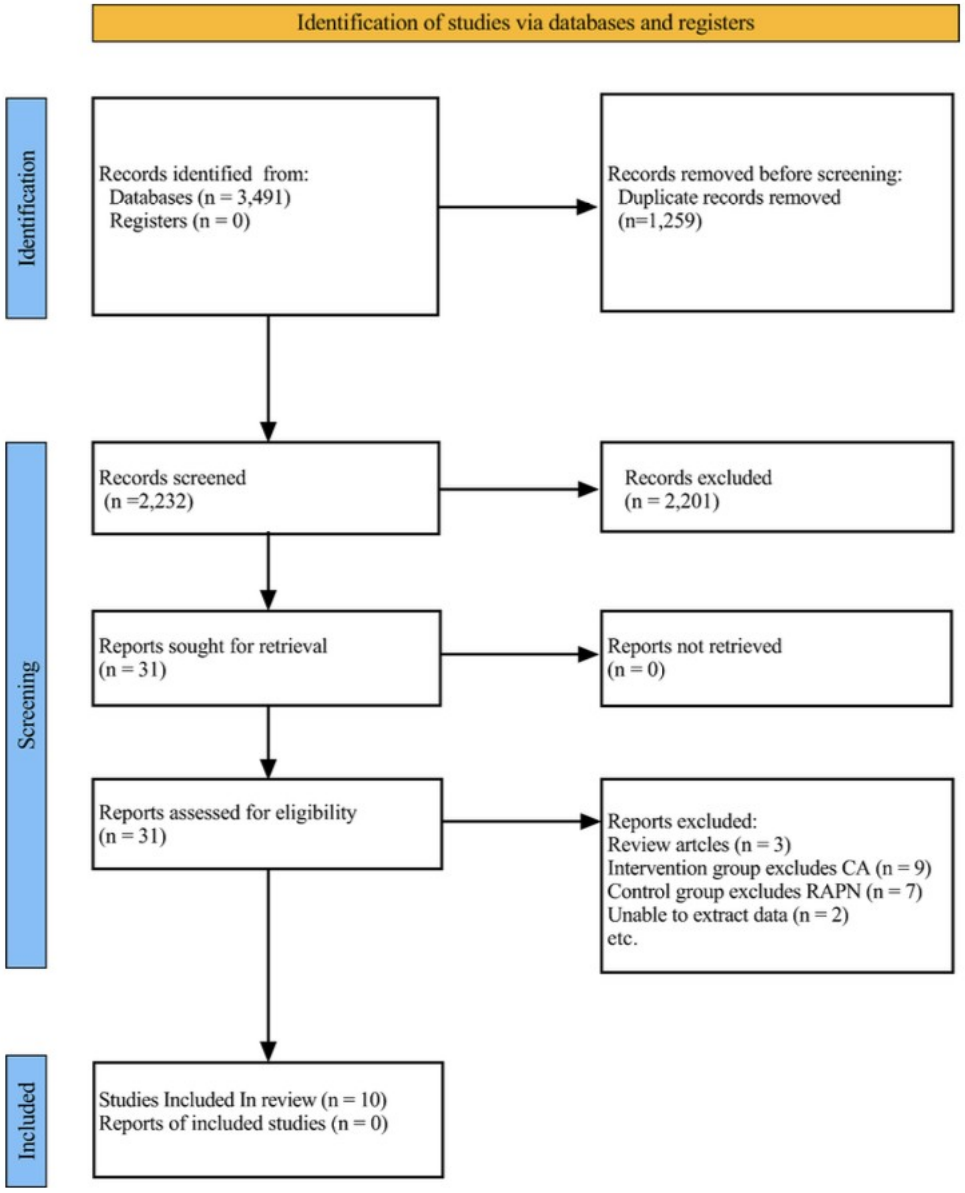


Table 1 Baseline characteristics

		Patients(*n*)		Age(year)		BMI(kg/m^2)		Tumor size(cm)		RENAL≥ 10(*n*)		CCI(*n*)		Surgical approach	Follow-up duration(month)	
Reference	**Country**	**CA**	**RAPN**	**CA**	**RAPN**	**CA**	**RAPN**	**CA**	**RAPN**	**CA**	**RAPN**	**CA**	**RAPN**		**CA**	**RAPN**
Kawaguchi, S [21]	Japan	49	50	78.44(4.7)	75.35(3.12)	23.7(3.8)	23.1(2.4)	2.4(0.8)	2.7(1.2)	0	1	NA.	NA.	PCA/RAPN	20.1(14.5)	24.3(14.5)
Uemura, T [25]	Japan	48	78	76.58(9.17)	60.65(12.84)	23.35(3.82)	23(3.02)	2.67(1.07)	1.9(0.6)	5	3	NA.	NA.	PCA/RAPN	16.96(19.87)	20.26(13.6)
Liu, HY [22]	Taiwan	55	55	59.44(14.77)	57.27(13.28)	25.04(4.23)	25.29(4.58)	3.86(2.13)	4.06(2.01)	14	11	NA.	NA.	LCA/RAPN	54.96(34.59)	33.2(19.55)
Rembeyo, G [23]	France	55	36	71.67(4.39)	60.09(2.65)	26.92(1.10)	29(1.51)	4.62(0.29)	4.55(0.34)	19	4	NA.	NA.	CA/RAPN	20.14(2.57)	23.73(3.95)
Fraisse, G [19]	France	177	177	69.94(9.38)	59.89(10.75)	NA.	NA.	2.59(0.86)	2.77(0.92)	10	10	3.21(1.72)	2.87(2.06)	PCA/RAPN	NA.	NA.
Bertolo, R [16]	America	65	65	79.3(4.1)	79.3(3.3)	27.9(5.9)	27.4(4.9)	3(1)	2.9(1)	NA.	NA.	2.3(1.6)	2(1.5)	PCA/RAPN	45.65(11.37)	36.65(11.37)
Caputo, P. A [17]	America	31	31	68.47(2.92)	68.47(2.92)	29.77(7.46)	31.49(8.63)	NA.	NA.	NA.	NA.	6(1.48)	4(1.48)	PCA/RAPN	11.71(12.44)	36.16(39.48)
Emara, A. M [18]	Britain	56	47	69.75(12)	60.5(10.5)	NA.(NA.)	NA.(NA.)	2.56(0.72)	3.28(1.22)	NA.	NA.	NA.	NA.	LCA/RAPN	31.3(13.48)	16.5(6.49)
Tanagho, Y [24]	America	267	233	69.3(11)	57.4(11.9)	30.4(7.8)	30.1(6)	2.5(1)	2.9(1.5)	NA.	NA.	6.5(2.2)	2.1(1.8)	LCA&PCA/RAPN	39.8(34.3)	21.9(18.8)
Guillotreau, J [20]	America	226	210	67.4(11.3)	57.8(11.8)	30.1(6.4)	29.3(6.2)	2.2(0.9)	2.4(0.8)	NA.	NA.	NA.	NA.	LCA/RAPN	39.76(43.35)	4.55(5.15)

CA, Cryoablation

PCA, Percutaneous Cryoablation

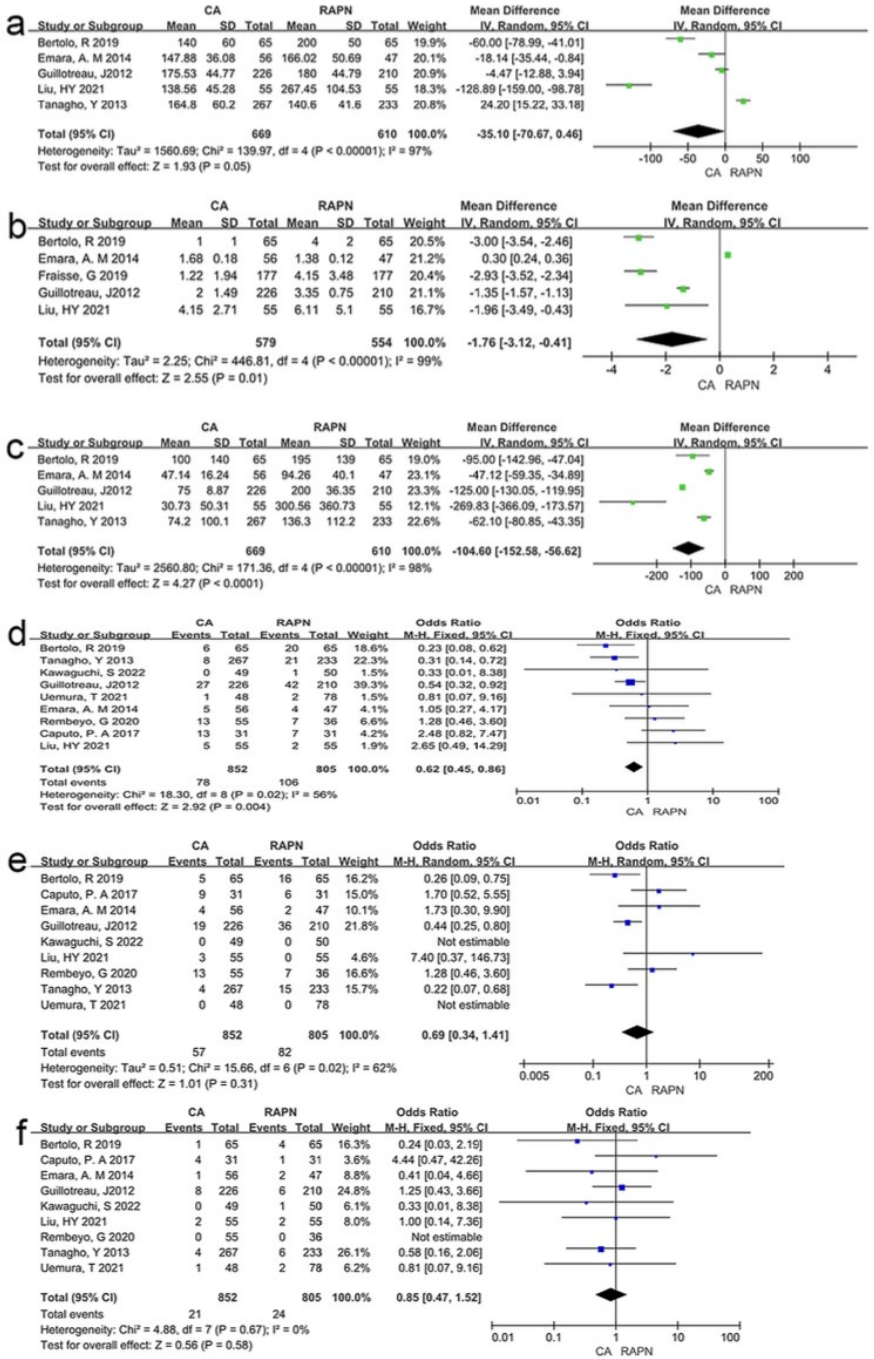
LCA, Laparoscopic Cryoablation

RAPN, Robot-Assisted Partial Nephrectomy

BMI, Body Mass Index

R.E.N.A.L. score, Renal Nephrometry Score

CCI, Charlson comorbidity index



OR Time – No Difference

LOS – Favors CA

[MD -1.76 days; 95% CI -3.12 to -0.41;p=0.01]

Blood Loss - Favors CA

[MD -104.60 ml; 95% CI -152.58 to -56.62; p < 0.0001],

Overall Complications – Favors CA

[OR 0.62; 95% CI 0.45 to 0.86; p=0.004],

Minor, Clavien 1-2 – No Difference

Major, Clavien 3-5 - NO Difference

Fig. 2 **A**-Operative Time, **B**-Length of Hospital Stay, **C**-Blood Loss, **D**-Overall Complications, **E**-Minor, Clavien 1–2, **F**-Major, Clavien 3–5

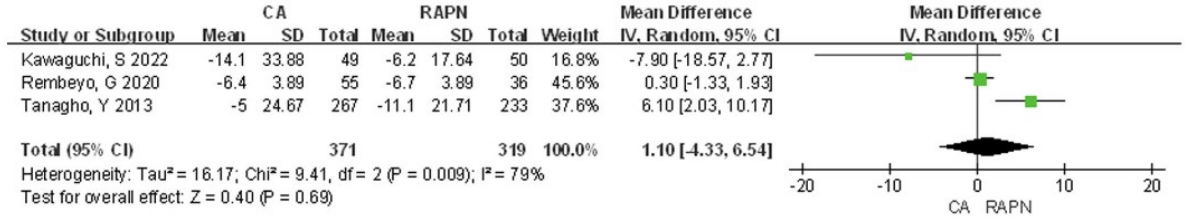
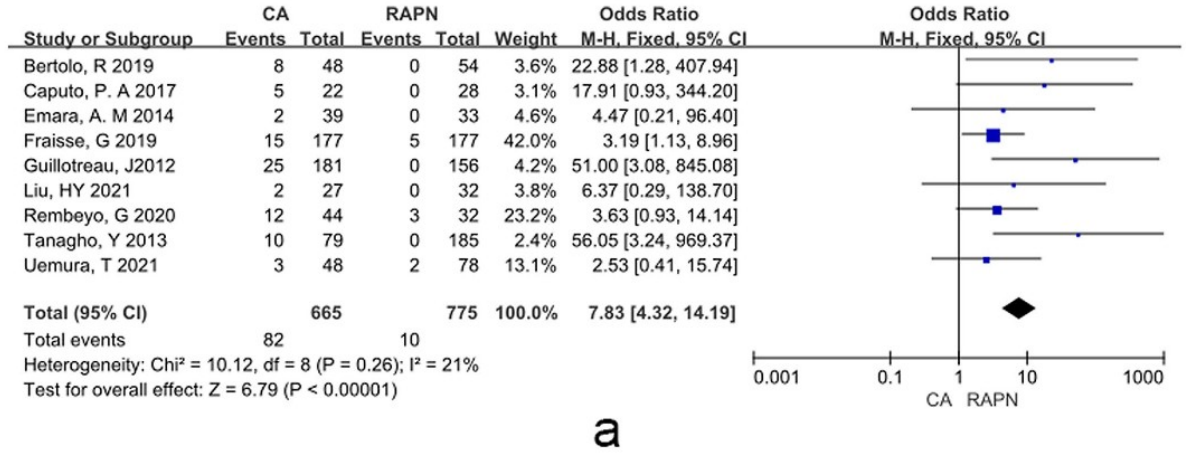


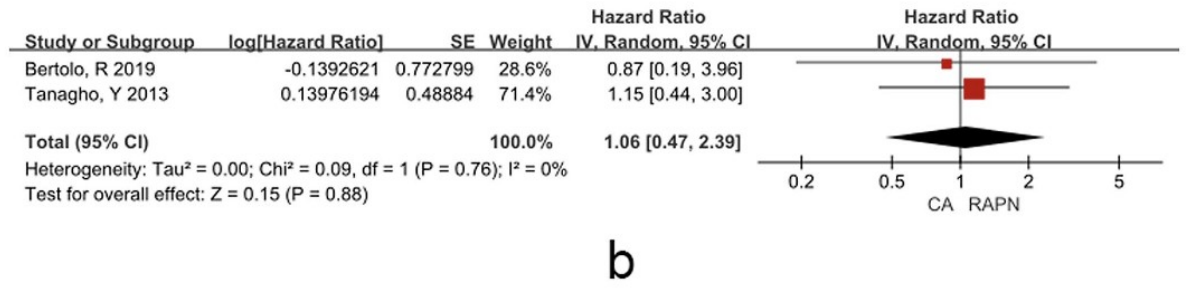
Fig. 3 Renal function 12 months post-surgery

Renal Function at 12 Months – No Difference



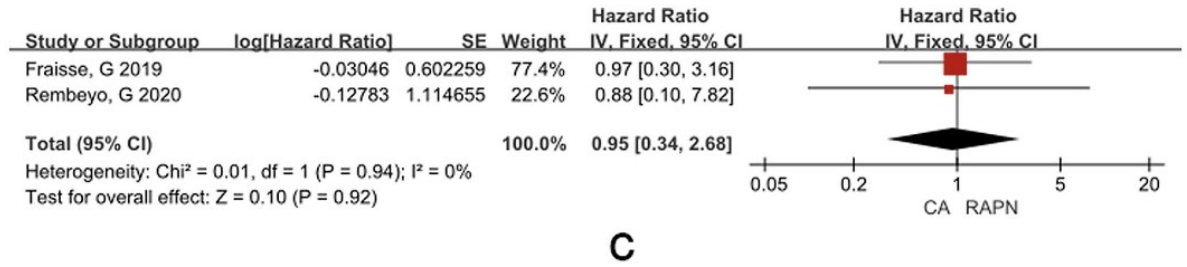
a

Recurrence Rate – Favors RAPN
[OR 7.83; 95% CI 4.32 to 14.19; p < 0.00001]



b

RFS – No Difference



c

OS – No Difference

Fig. 4 **A**- Recurrence Rate, **B**-RFS, **C**-OS

Limitations

- **No High Quality RCTs** (Only retrospective and prospective cohort studies)
- **Different CA techniques** (PCA, LCA) were included in the review without sufficient literature to conduct a subgroup analysis on CA techniques, possibly leading to high heterogeneity.
- **CA** is often used in **older patients with multiple comorbidities**
- **Data does not yet support subgroup analysis** of patients with cT1a and cT1b tumors together, and further research is needed in the future.
- **Variations in surgical experience and equipment** may lead to differences

Conclusion

CA vs RAPN:

- CA offers better short-term outcomes (hospital stay, blood loss, complications).
- Comparable renal function and survival.
- **Major drawback:** Significantly higher recurrence with CA.

Clinical Implication:

- CA viable for non-surgical candidates; RAPN remains gold standard for curative intent.

Future Needs:

- RCTs to validate long-term outcomes and subgroup analyses (e.g., cT1a vs. cT1b).

Thank you!