

Online Resource 1

Inadequate Ablative Margins in Colorectal Liver Metastases: Systematic Review, Meta-analysis, Evidence Map, and Public Computed Tomography Study

CardioVascular and Interventional Radiology
Author information withheld for double-blind review

Supplementary Methods

The review protocol was prospectively registered as PROSPERO CRD420261444590. Two complementary searches were used for each source: a core actionability strategy requiring a clinical outcome or retreatment concept, and a broad sensitivity strategy without that final concept. Searches ran during 2-6 July 2026 with no date or language restriction.

Records were combined across databases and ClinicalTrials.gov before deduplication. Machine-generated relevance labels prioritized the screening queue only. Human review determined every final inclusion, exclusion, numerical extraction, study-family assignment, and risk-of-bias judgement. A separate full-report pass checked included, borderline, quantitative, and overlapping reports.

The primary synthesis pooled adjusted time-to-event effects. Restricted maximum likelihood estimated between-study variance; Hartung-Knapp intervals were used because the number of studies was small. Analyses were performed on log-transformed effects. Sensitivity analyses excluded the mixed-tumour subgroup using a margin below 4 mm, restricted the pool to conventional hazard ratios, and substituted a later prospective report within an overlapping study family. Local salvage proportions were transformed and pooled with patient/report-level denominators as reported.

For imaging, connected tumour components were manually adjudicated, then frozen. Voxel spacing informed volume, bounding-box dimension, capsule distance, vessel distance, and virtual expansion. The analysis-liver mask combined source liver, hepatic/portal vessel, and source tumour labels. A virtual margin was fully contained only when no expanded voxel lay outside that mask. Vessel conflict required intersection with the hepatic or portal vessel mask. Confidence intervals came from 10,000 bootstrap samples of patients with replacement.

Supplementary Limitations

The review was not screened independently by two reviewers, and 176 reports sought for retrieval were unavailable. Statistical reporting bias was not modelled because no synthesis included ten studies. The evidence map score is descriptive and may reflect publication year or study purpose.

The imaging analysis measures theoretical pre-treatment constraint, not achieved minimal ablative margin. It cannot capture probe trajectory, thermal dose, tissue contraction, heat sink, organ motion, registration error, operator technique, or unsegmented critical structures. Approximate maximum diameter is a bounding-box metric. The exploratory four-feature score is unweighted and unvalidated.

Supplementary Tables

Table S1 Search sources and record counts

Platform	Resources	Records	Notes
Ovid multi-database platform	Ovid MEDLINE ALL; Embase Classic+Embase; Emcare; Global Health; HMIC; MIDIRS; PsycInfo; PsycArticles Full Text; Journals@Ovid Full Text; Books@Ovid; Imperial Journals@Ovid	1,861	Core and broad exports; exact resource coverage recorded from the run log
PubMed	PubMed	395	157 core; 238 broad
CENTRAL	Cochrane Central Register of Controlled Trials	49	28 core; 21 broad
Scopus	Scopus	676	415 core; 261 broad
Web of Science	Web of Science Core Collection	661	387 core; 274 broad
ClinicalTrials.gov	ClinicalTrials.gov	97	Registry keyword searches
Total	Databases 3,642; registry 97	3,739	2,763 duplicates removed; 976 unique records screened

Run/export window: 2-6 July 2026. Ovid resource updates extended through 2 July 2026.

Table S2 Included reports, margin workflow, action loop, and analysis role

Study	Design and sample	Ablation / assessment	Threshold and timing	Action loop / outcomes	Analysis role / risk of bias
Frich 2007	prospective/retrospective small cohort; 11/11	RFA; visual 2D/anatomic	<5 mm; follow-up	no predefined action; LTP	sensitivity only; serious
Liu 2010	retrospective mixed tumour cohort; 28 patients/38 CRLM	RFA; 2D CT landmarks	<4 mm; follow-up	not stated; LTP HR	adjusted threshold sensitivity; serious
Wang 2013	retrospective cohort; 64 patients/94 lesions	RFA; 2D landmarks	categorical 0,1–5,6–10,>10; follow-up	not predefined; LTP	overlapping cohort; excluded primary; serious
Sotirchos 2016	prospective cohort; 47 patients/67 lesions	RFA/MWA; 2D + biopsy	<5 mm; immediate biopsy	biopsy prognostic; no protocol correction; LTP	overlapping cohort; companion evidence; moderate
Shady 2018	retrospective cohort; 110 patients/145 lesions	RFA/MWA; 2D CT landmarks	≤5 and ≤10 mm; follow-up	not predefined; LTP	overlapping cohort; sensitivity; serious
Calandri 2018	retrospective two-centre cohort; 136 patients/218 lesions	MWA; 2D CT landmarks	≤10 mm; follow-up	salvage after LTP reported; LTP, salvage	adjusted primary 10-mm evidence; serious
Kaye 2019	retrospective cohort; 72 patients/93 lesions	RFA/MWA; 3D registration	incomplete,0,1–5,6–10,>10; retrospective	not predefined; LTP	overlapping cohort; sensitivity; serious
Han 2021	retrospective development/validation cohort; 365 patients/512 lesions	RFA; 2D CT landmarks	≤5 mm; 1-month CT	repeat RFA for residual/LTP when feasible; LTP, salvage, complications	adjusted primary; moderate-serious
Laimer 2021	retrospective cohort; 76 lesions	stereotactic RFA; 3D rigid registration/coverage	complete 5-mm coverage; intraprocedural/retrospective	not predefined for study; LTP	raw incomplete-coverage analysis; serious
Ruiter 2021	retrospective cohort; 47 patients/65 lesions	RFA/MWA; 3D quantitative spatial margin	continuous and surface <1 mm; retrospective	not predefined; ASR/LTP	narrative spatial evidence; serious
De Cobelli 2022	retrospective cohort; 132 patients/213 lesions	MWA; 2D CT landmarks	<5 mm; follow-up	not predefined; LTP, complications	narrative; no extractable CI for margin; serious
Faber 2022	retrospective technical cohort; 21 patients/29 lesions	MWA; 3D deformable registration	negative vs nonnegative; retrospective	not predefined; LTR	raw incomplete-coverage analysis; serious
Joo 2022	retrospective mixed tumour cohort; 172 patients/334 lesions; 94 CRLM	MWA; intra-procedural CT; visual ± software	≥10 mm for CRLM; intraprocedural	immediate additional ablation; LTP, margin adequacy	actionability evidence; serious
Vasiniotis Kamarinos 2022	prospective cohort; 107 patients/182 lesions	RFA/MWA; 2D/3D + biopsy	<5 mm; immediate biopsy and follow-up	no systematic margin correction; LTP, complications	adjusted and raw primary; moderate
Wada 2023	retrospective surgical cohort; 195 patients/1066 ablated lesions	MWA; 2D anatomic landmarks	<5 mm; postoperative CT	not predefined; local recurrence	raw primary; clustering limitation; serious
Lin 2023	retrospective cohort; 124 patients/213 lesions	RFA/MWA; 3D biomechanical deformable + autosegmentation	0,>0–<5,≥5; retrospective	not used to guide treatment; LDP	raw primary; institutional overlap managed; serious
Paolucci 2024	retrospective cohort; 243 patients/400 lesions	RFA/MWA; 3D deformable registration	0,>0–<5,≥5; retrospective	not predefined; LDP	primary multicentre narrative; component overlap; moderate-serious
Lin 2024	retrospective technical cohort; 72 patients/139 lesions	RFA/MWA; rigid vs deformable 3D	continuous/categorical; retrospective	not predefined; LTP, diagnostic accuracy	engineering evidence map; serious
COVER-ALL 2025	randomised phase 2 mixed histology; 50 randomised + 50 extension; 51 CRLM	predominantly MWA; intraprocedural 3D software vs visual	target ≥5 mm; intraprocedural	software feedback triggered reablation; MAM, LTP, adverse events	contextual randomized actionability; CRLM outcome not separable; some concerns
Shur 2025	retrospective technical cohort; 60 patients/97 lesions	MWA; visual, rigid and deformable 3D	incomplete/0/>0; delayed pre/post CT	not actionable due delayed scans; residual tumour/LTP	raw incomplete-coverage + evidence map; serious
Lu 2025	prospective cohort; 200 patients/410 lesions	RFA; DCE-CT landmarks	continuous MAM/residual disease; immediate or 4–8 weeks	repeat RFA for residual disease; residual, LTP, salvage, OS	salvage/actionability narrative; serious
Laimer 2025	retrospective validation cohort; 113 patients/189 lesions; 173 analysable	RFA/MWA; 3D software comparison	continuous per-mm; intraprocedural/early	not predefined; LTP	technical validation; overlap managed; serious
OPTABLATE 2026	prospective phase II/III cohort; 77 patients/104 lesions	MWA; 3D margin + PET/CT + rapid biopsy	<5 mm or viable tumour/PET avidity; intraprocedural	immediate reablation protocol; LTP, action, complications	key actionability evidence; sensitivity adjusted effect; moderate
Syversveen 2026	retrospective comparative cohort; 137 patients/243 lesions	RFA/MWA; intraoperative CT vs ultrasound-only	target 10 mm; intraprocedural	immediate reablation for extension; LTP, complications, salvage	only CRLM-specific comparative action study; serious

Table S3 Risk-of-bias summary

Design	Judgement	Reports	Dominant concerns
Non-randomized	Serious	18	Confounding; retrospective selection; lesion clustering; incomplete adjustment; selective threshold reporting
Non-randomized	Moderate-serious	2	Residual confounding and selection remained material
Non-randomized	Moderate	3	Prospective methods or stronger measurement reduced, but did not remove, bias
Randomized	Some concerns	1	Small phase 2 sample; colorectal-specific outcome not separable

Table S4 Primary clinical synthesis, sensitivity analyses, actionability, and salvage

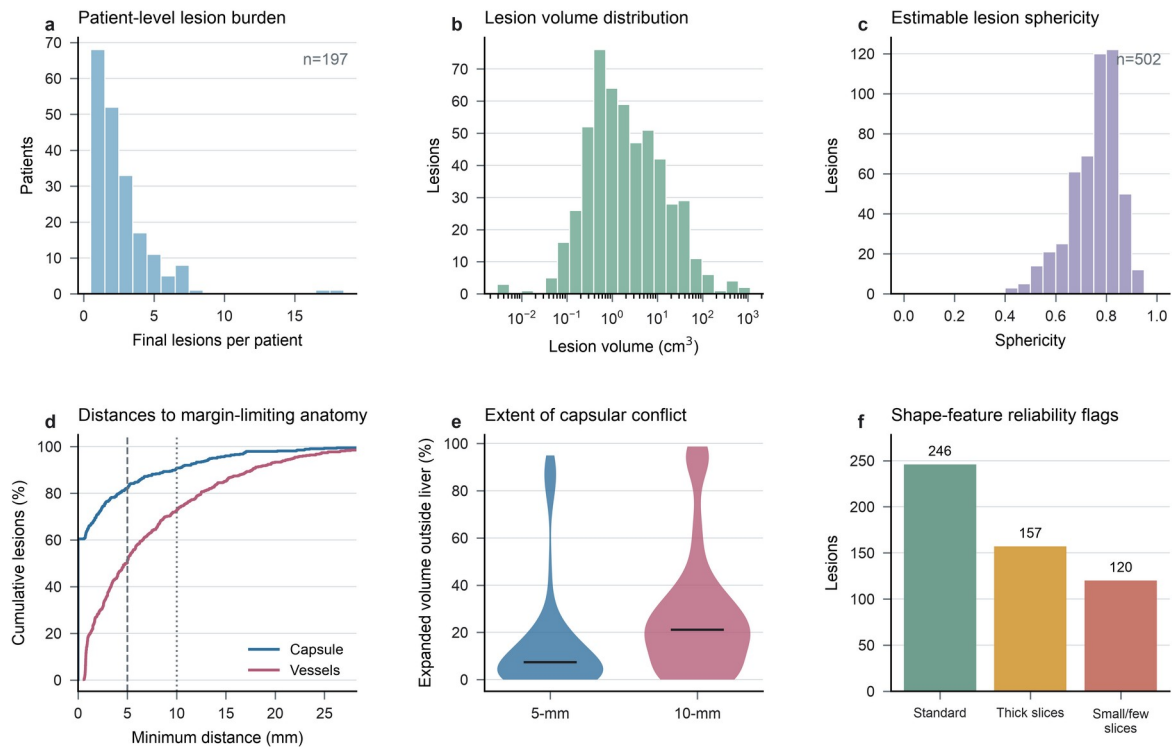
Estimand	Evidence	Estimate (95% CI)	Heterogeneity / decision	Clinical interpretation
Inadequate vs adequate margin; adjusted time-to-LTP	4 independent adjusted reports	Relative hazard 3.59 (1.00-12.96; exact lower limit 0.996)	I2 70.2%; tau2 0.44; PI 0.13-100.23	Directionally consistent association, but small and heterogeneous evidence base.
Sensitivity: exclude <4-mm mixed-tumour subgroup	3 reports	Relative hazard 4.22 (0.52-34.21)	I2 77.8%	Point estimate stable; inference imprecise.
Sensitivity: conventional HRs only	3 reports	HR 3.63 (0.28-46.37)	I2 80.1%	Mixing HR and SHR did not explain heterogeneity.
Sensitivity: prospective multimodal report replaces earlier institutional report	4 reports	Relative hazard 4.48 (1.02-19.76)	I2 77.3%	Supports direction but remains heterogeneous.
Intra-procedural CT control vs ultrasound-only	Syversveen 2026; CRLM-specific observational cohort	RR 0.27 (0.11-0.69); 5/111 vs 22/132	Not pooled	Directly relevant action comparison; vulnerable to temporal and selection confounding.
Software-based vs visual assessment	COVER-ALL 2025; mixed histology randomised trial	RR 0.27 (0.03-2.26); 1/24 vs 4/26	Not pooled; CRLM outcome not separable	Contextual randomised evidence; underpowered for local progression.
Reports with predefined immediate/early corrective pathway	5 of 24 reports	20.8%	Descriptive only	Most literature measured risk without closing the action loop.
Local salvage after LTP	3 compatible cohorts; 71/228 progressions	31.3% (20.2%-45.0%)	I2 0%; PI 7.5%-71.9%	A meaningful minority remained locally treatable.
Complications after completion, repeat, or salvage treatment	Heterogeneous definitions and denominators	Major or major-equivalent rates approximately 1.2%-11%	Not pooled	Comparative incremental morbidity could not be estimated.

Table S5 Expanded frozen imaging summary

domain	measure	result	reporting_unit
Cohort	Patients	197	n
Cohort	Final lesions	523	n
Patient burden	Lesions per patient	2 (1-3)	median (IQR)
Lesion size	Approximate maximum diameter	18.1 (12.2-30.4)	mm, median (IQR)
Lesion size	Volume	1.59 (0.50-7.54)	cm3, median (IQR)
Anatomical constraint	Subcapsular at 5 mm	429/523 (82.0%)	n/N (%)
Anatomical constraint	Subcapsular at 10 mm	473/523 (90.4%)	n/N (%)
Anatomical constraint	Perivascular at 5 mm	263/523 (50.3%)	n/N (%)
Anatomical constraint	Perivascular at 10 mm	378/523 (72.3%)	n/N (%)
Anatomical constraint	Both at 5 mm	200/523 (38.2%)	n/N (%)
Anatomical constraint	Both at 10 mm	336/523 (64.2%)	n/N (%)
Virtual margin	5 mm expansion fully contained within analysis liver	117/523 (22.4%)	n/N (%)
Virtual margin	10 mm expansion fully contained within analysis liver	65/523 (12.4%)	n/N (%)
Exploratory four-feature constraint category	Low	49/523 (9.4%)	n/N (%)
Exploratory four-feature constraint category	Intermediate	409/523 (78.2%)	n/N (%)
Exploratory four-feature constraint category	High	65/523 (12.4%)	n/N (%)
Shape quality	3D shape features estimable	502/523 (96.0%)	n/N (%)
Shape quality	Single-slice, not reliable	18	n
Shape quality	Too few voxels, not estimable	3	n

Supplementary Figure

Fig. S1 Lesion phenotypes and measurement-quality context. a Final post-adjudication lesions per patient. b Lesion volume on a logarithmic axis. c Sphericity among lesions with estimable surface-derived features. d Empirical cumulative distributions of minimum capsule and vessel distance; vertical lines mark 5 mm and 10 mm. e Percentage of each virtual expansion outside the analysis-liver mask. f Reliability flags for surface-derived shape features. No inferential comparisons were performed



Full Search Strategies

The strategies below reproduce the prospectively prepared source-specific syntax. The Ovid strategy was executed on a multi-database platform; Table S1 records the resources actually present in that run.

4. PubMed

4.1 PubMed Search A - core actionability search

```
(
colorectal[tiab] OR colon[tiab] OR rectal[tiab] OR CRC[tiab]
)
AND
(
"liver metastasis"[tiab] OR "liver metastases"[tiab] OR "hepatic metastasis"[tiab]
OR "hepatic metastases"[tiab] OR CLM[tiab] OR CRLM[tiab]
)
AND
(
ablation[tiab] OR "thermal ablation"[tiab] OR "radiofrequency ablation"[tiab]
OR RFA[tiab] OR "microwave ablation"[tiab] OR MWA[tiab]
OR thermoablation[tiab] OR "image-guided ablation"[tiab]
)
AND
(
margin[tiab] OR margins[tiab] OR "ablation margin"[tiab]
OR "ablative margin"[tiab] OR "minimal ablation margin"[tiab]
OR "minimal ablative margin"[tiab] OR MAM[tiab]
OR A0[tiab] OR A1[tiab]
OR "incomplete ablation"[tiab] OR "residual disease"[tiab]
OR "residual tumour"[tiab] OR "residual tumor"[tiab]
OR "insufficient coverage"[tiab] OR "volume of insufficient coverage"[tiab]
)
AND
(
"local tumor progression"[tiab] OR "local tumour progression"[tiab]
OR LTP[tiab] OR recurrence[tiab] OR "local recurrence"[tiab]
OR reablation[tiab] OR "re-ablation"[tiab] OR "repeat ablation"[tiab]
OR "completion ablation"[tiab] OR salvage[tiab]
OR retreatment[tiab] OR "re-treatment"[tiab]
)
)
```

4.2 PubMed Search B - broad sensitivity search

```
(
```

```

colorectal[tiab] OR colon[tiab] OR rectal[tiab] OR CRC[tiab]
)
AND
(
"liver metastasis"[tiab] OR "liver metastases"[tiab] OR "hepatic metastasis"[tiab]
OR "hepatic metastases"[tiab] OR CLM[tiab] OR CRLM[tiab]
)
AND
(
ablation[tiab] OR "thermal ablation"[tiab] OR "radiofrequency ablation"[tiab]
OR RFA[tiab] OR "microwave ablation"[tiab] OR MWA[tiab]
OR thermoablation[tiab] OR "image-guided ablation"[tiab]
)
AND
(
margin[tiab] OR margins[tiab] OR "ablation margin"[tiab]
OR "ablative margin"[tiab] OR "minimal ablation margin"[tiab]
OR "minimal ablative margin"[tiab] OR MAM[tiab]
OR A0[tiab] OR A1[tiab]
OR "incomplete ablation"[tiab] OR "residual disease"[tiab]
OR "residual tumour"[tiab] OR "residual tumor"[tiab]
OR "insufficient coverage"[tiab] OR "volume of insufficient coverage"[tiab]
)

```

5. Ovid MEDLINE

The following line-by-line strategy is designed for Ovid MEDLINE. If an institutional Ovid platform searches multiple databases simultaneously, the searched resources should be recorded exactly in the search log and manuscript supplement.

1. exp Colorectal Neoplasms/
 2. (colorectal or colon or rectal or CRC).ti,ab.
 3. 1 or 2
 4. exp Liver Neoplasms/
 5. ((liver or hepatic) adj3 (metasta* or secondar*)).ti,ab.
 6. (CLM or CRLM).ti,ab.
 7. 4 or 5 or 6
 8. exp Ablation Techniques/
 9. (ablation or "thermal ablation" or "radiofrequency ablation" or RFA or "microwave ablation" or MWA or thermoablation or "image-guided ablation").ti,ab.
 10. 8 or 9
 11. (margin or margins or "ablation margin" or "ablative margin" or "minimal ablation margin" or "minimal ablative margin" or MAM or A0 or A1).ti,ab.
 12. ("incomplete ablation" or "residual disease" or "residual tumour" or "residual tumor" or "insufficient coverage" or "volume of insufficient coverage").ti,ab.
 13. 11 or 12
 14. ("local tumor progression" or "local tumour progression" or LTP or recurrence or "local recurrence").ti,ab.
 15. (reablation or "re-ablation" or "repeat ablation" or "completion ablation" or salvage or retreatment or "re-treatment").ti,ab.
 16. 14 or 15
 17. 3 and 7 and 10 and 13 and 16
 18. 3 and 7 and 10 and 13
- Line 17 is the core actionability search. Line 18 is the broad sensitivity search.

6. Embase

6.1 Embase Search A - core actionability search

```

('colorectal cancer'/exp OR colorectal:ti,ab OR colon:ti,ab OR rectal:ti,ab OR CRC:ti,ab)
AND
('liver metastasis'/exp OR 'liver metastases':ti,ab OR 'liver metastasis':ti,ab OR 'hepatic
metastasis':ti,ab OR 'hepatic metastases':ti,ab OR CLM:ti,ab OR CRLM:ti,ab)
AND
('radiofrequency ablation'/exp OR 'microwave ablation'/exp OR ablation:ti,ab OR 'thermal
ablation':ti,ab OR 'radiofrequency ablation':ti,ab OR RFA:ti,ab OR 'microwave ablation':ti,ab OR
MWA:ti,ab OR thermoablation:ti,ab)
AND
(margin:ti,ab OR margins:ti,ab OR 'ablation margin':ti,ab OR 'ablative margin':ti,ab OR 'minimal
ablation margin':ti,ab OR 'minimal ablative margin':ti,ab OR MAM:ti,ab OR A0:ti,ab OR A1:ti,ab OR
'incomplete ablation':ti,ab OR 'residual disease':ti,ab OR 'residual tumour':ti,ab OR 'residual
tumor':ti,ab OR 'insufficient coverage':ti,ab OR 'volume of insufficient coverage':ti,ab)
AND
('local tumor progression':ti,ab OR 'local tumour progression':ti,ab OR LTP:ti,ab OR
recurrence:ti,ab OR 'local recurrence':ti,ab OR reablation:ti,ab OR 're-ablation':ti,ab OR 'repeat
ablation':ti,ab OR 'completion ablation':ti,ab OR salvage:ti,ab OR retreatment:ti,ab OR 're-
treatment':ti,ab)

```

6.2 Embase Search B - broad sensitivity search

```

('colorectal cancer'/exp OR colorectal:ti,ab OR colon:ti,ab OR rectal:ti,ab OR CRC:ti,ab)
AND
('liver metastasis'/exp OR 'liver metastases':ti,ab OR 'liver metastasis':ti,ab OR 'hepatic
metastasis':ti,ab OR 'hepatic metastases':ti,ab OR CLM:ti,ab OR CRLM:ti,ab)
AND

```

```
( 'radiofrequency ablation'/exp OR 'microwave ablation'/exp OR ablation:ti,ab OR 'thermal
ablation':ti,ab OR 'radiofrequency ablation':ti,ab OR RFA:ti,ab OR 'microwave ablation':ti,ab OR
MWA:ti,ab OR thermoablation:ti,ab)
AND
(margin:ti,ab OR margins:ti,ab OR 'ablation margin':ti,ab OR 'ablative margin':ti,ab OR 'minimal
ablation margin':ti,ab OR 'minimal ablative margin':ti,ab OR MAM:ti,ab OR A0:ti,ab OR A1:ti,ab OR
'incomplete ablation':ti,ab OR 'residual disease':ti,ab OR 'residual tumour':ti,ab OR 'residual
tumor':ti,ab OR 'insufficient coverage':ti,ab OR 'volume of insufficient coverage':ti,ab)
7. Cochrane CENTRAL
```

7.1 CENTRAL Search A - core actionability search

```
(colorectal OR colon OR rectal OR CRC)
AND
("liver metastasis" OR "liver metastases" OR "hepatic metastasis" OR "hepatic metastases" OR CLM OR
CRLM)
AND
(ablation OR "thermal ablation" OR "radiofrequency ablation" OR RFA OR "microwave ablation" OR MWA
OR thermoablation)
AND
(margin OR margins OR "ablation margin" OR "ablative margin" OR "minimal ablation margin" OR
"minimal ablative margin" OR MAM OR A0 OR A1 OR "incomplete ablation" OR "residual disease" OR
"residual tumour" OR "residual tumor")
AND
("local tumor progression" OR "local tumour progression" OR LTP OR recurrence OR "local recurrence"
OR reablation OR "re-ablation" OR "repeat ablation" OR "completion ablation" OR salvage OR
retreatment OR "re-treatment")
```

7.2 CENTRAL Search B - broad sensitivity search

```
(colorectal OR colon OR rectal OR CRC)
AND
("liver metastasis" OR "liver metastases" OR "hepatic metastasis" OR "hepatic metastases" OR CLM OR
CRLM)
AND
(ablation OR "thermal ablation" OR "radiofrequency ablation" OR RFA OR "microwave ablation" OR MWA
OR thermoablation)
AND
(margin OR margins OR "ablation margin" OR "ablative margin" OR "minimal ablation margin" OR
"minimal ablative margin" OR MAM OR A0 OR A1 OR "incomplete ablation" OR "residual disease" OR
"residual tumour" OR "residual tumor")
8. Web of Science Core Collection
```

8.1 Web of Science Search A - core actionability search

```
TS=(
(colorectal OR colon OR rectal OR CRC)
AND
("liver metastasis" OR "liver metastases" OR "hepatic metastasis" OR "hepatic metastases" OR CLM OR
CRLM)
AND
(ablation OR "thermal ablation" OR "radiofrequency ablation" OR RFA OR "microwave ablation" OR MWA
OR thermoablation)
AND
(margin OR margins OR "ablation margin" OR "ablative margin" OR "minimal ablation margin" OR
"minimal ablative margin" OR MAM OR A0 OR A1 OR "incomplete ablation" OR "residual disease" OR
"residual tumour" OR "residual tumor")
AND
("local tumor progression" OR "local tumour progression" OR LTP OR recurrence OR "local recurrence"
OR reablation OR "re-ablation" OR "repeat ablation" OR "completion ablation" OR salvage OR
retreatment OR "re-treatment")
)
```

8.2 Web of Science Search B - broad sensitivity search

```
TS=(
(colorectal OR colon OR rectal OR CRC)
AND
("liver metastasis" OR "liver metastases" OR "hepatic metastasis" OR "hepatic metastases" OR CLM OR
CRLM)
AND
(ablation OR "thermal ablation" OR "radiofrequency ablation" OR RFA OR "microwave ablation" OR MWA
OR thermoablation)
AND
(margin OR margins OR "ablation margin" OR "ablative margin" OR "minimal ablation margin" OR
"minimal ablative margin" OR MAM OR A0 OR A1 OR "incomplete ablation" OR "residual disease" OR
"residual tumour" OR "residual tumor")
)
9. Scopus
```

9.1 Scopus Search A - core actionability search

```
TITLE-ABS-KEY(  
(colorectal OR colon OR rectal OR CRC)  
AND  
("liver metastasis" OR "liver metastases" OR "hepatic metastasis" OR "hepatic metastases" OR CLM OR  
CRLM)  
AND  
(ablation OR "thermal ablation" OR "radiofrequency ablation" OR RFA OR "microwave ablation" OR MWA  
OR thermoablation)  
AND  
(margin OR margins OR "ablation margin" OR "ablative margin" OR "minimal ablation margin" OR  
"minimal ablative margin" OR MAM OR A0 OR A1 OR "incomplete ablation" OR "residual disease" OR  
"residual tumour" OR "residual tumor")  
AND  
("local tumor progression" OR "local tumour progression" OR LTP OR recurrence OR "local recurrence"  
OR reablation OR "re-ablation" OR "repeat ablation" OR "completion ablation" OR salvage OR  
retreatment OR "re-treatment")  
)
```

9.2 Scopus Search B - broad sensitivity search

```
TITLE-ABS-KEY(  
(colorectal OR colon OR rectal OR CRC)  
AND  
("liver metastasis" OR "liver metastases" OR "hepatic metastasis" OR "hepatic metastases" OR CLM OR  
CRLM)  
AND  
(ablation OR "thermal ablation" OR "radiofrequency ablation" OR RFA OR "microwave ablation" OR MWA  
OR thermoablation)  
AND  
(margin OR margins OR "ablation margin" OR "ablative margin" OR "minimal ablation margin" OR  
"minimal ablative margin" OR MAM OR A0 OR A1 OR "incomplete ablation" OR "residual disease" OR  
"residual tumour" OR "residual tumor")  
)
```

10. ClinicalTrials.gov

ClinicalTrials.gov will be searched using simple keyword searches rather than one long Boolean strategy. Each query will be run separately and exported, where export is available.

colorectal liver metastases ablation

colorectal liver metastases radiofrequency ablation

colorectal liver metastases microwave ablation

CRLM ablation

liver metastases colorectal ablation margin

colorectal liver metastases local tumor progression ablation

colorectal liver metastases reablation

colorectal liver metastases salvage ablation