

Entity-Constrained CBCT Retrieval for Low-Resource Dental Record Completion

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1. Motivation / Challenge

- Complete structured dental records from CBCT under extreme low-resource supervision.
- Only 50 labeled CBCT cases and 161 labeled visits aggregated into structured records.
- Strict scoring depends on correct FDI tooth positions and ICD codes.
- Unrestricted retrieval can inject unsupported entities.

Table 1. Field heterogeneity motivates entity-constrained retrieval update. Statistics cover 161 labeled visits; Filled (%) denotes non-empty rows and Unique counts distinct non-empty strings. Oral check corresponds to the Oral exam aspect of the official metric.

Field	Filled (%)	Unique	Observed structure
Handle	96	145	Near visit-specific
Oral check	93	146	Near visit-specific
Doctor advices	80	59	Strongly templated
Diagnosis	76	99	Diverse, recurrent groups
Treatment plan	59	88	Diverse, incomplete
Main appeal	34	50	Sparse
Present medical history	28	43	Sparse

4. Ablation and Analysis

Table 4. Update-rule ablation on the strict LOO proxy (50 labeled cases, 0–1 scale, no corpus-level term). Injections counts fields whose emitted *Diagnosis* contains an FDI or ICD entity absent from the prior.

Method	Proxy	Inject.
Text prior	0.1831	0/50
Diagnosis replace	0.1542	40/50
Naive append	0.1833	40/50
Entity-safe append (ours)	0.1831	0/50

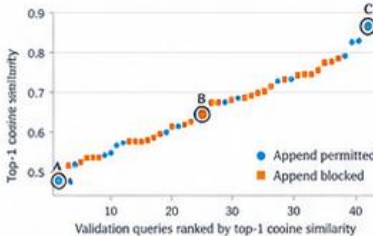


Fig. 2. Similarity alone does not determine safe admission. Validation queries are ranked by top-1 cosine similarity. Blue candidates satisfy the entity constraint.

- Entity-safe append preserves zero injections.
- Naive append and replacement propagate unsupported entities in 40/50 LOO folds.
- Similarity alone does not determine safe admission.

2. Method / ECCR Pipeline

Retrieved evidence is controlled rather than copied.

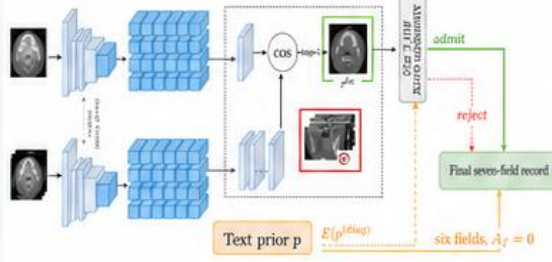


Fig. 1. Retrieved evidence is controlled rather than copied. A frozen 3D encoder retrieves a neighbour, while prior p supplies all seven fields. Retrieval may propose a *Diagnosis* update only ($A_f = 0$ otherwise), and admission requires $\mathcal{E}(r) \subseteq \mathcal{E}(p)$.

- BLEU-medoid text prior supplies all seven fields.
- A frozen Med3D VisionTower retrieves candidate *Diagnosis* evidence from CBCT.
- Only *Diagnosis* can be updated.
- Admission requires entity consistency: $\mathcal{E}(r^{(diag)}) \subseteq \mathcal{E}(p^{(diag)})$.
- If admitted, append after exact-duplicate removal; otherwise retain the prior.
- Parameter-free, no task-specific training.

5. Score Decomposition, Limitations, Conclusion

Table 7. Sub-metric decomposition of ECCR's final score. Points are on the 100-point scale before the diversity factor; Credited applies $\phi = 0.56$. Completeness sub-metrics combine a completion rate and ROUGE-L and are reported at aspect level only.

Aspect (Points / Credited)	Sub-metric	n	F1	Points
Diagnosis 8.73 / 4.89	Condition detection	47	0.2345	4.69
	Tooth-condition match	32	0.0159	0.16
	ICD codes	40	0.1630	1.63
	Whole-mouth	20	0.4500	2.25
Oral exam 0.00 / 0.00	Findings detection	34	0.0000	0.00
	Tooth-level findings	21	0.0000	0.00
	Whole-mouth findings	7	0.0000	0.00
	Findings detection	34	0.0000	0.00
Treatment 4.85 / 2.72	Action detection	42	0.4762	4.76
	Tooth-level actions	32	0.0000	0.00
	Handled actions	29	0.0172	0.09
	Handled actions	29	0.0172	0.09
Completeness 6.72 / 3.76 (main appeal 3.18, past 0.00, advices 1.64)				
Total				20.30 → 11.37

Limitations (Section 6)

- Guarantee covers only extracted FDI positions and dental ICD-10 codes, not free-text clinical concepts.
- The invariant is one-sided: it bounds entity precision by the prior but caps entity recall by the prior's coverage.
- Restricting authority to *Diagnosis* forfeits the *Oral exam* aspect.
- Comparison against full-record retrieval is confounded by encoder choice and the fixed single split has no variance estimate.

3. Key Results

Public validation score (ours)

0.3134

Comparison with baselines (Table 3)

Table 3. Public-validation comparison of evidence authority (0–1 scale). Full authority replaces the complete record, no authority emits the text prior, and ECCR permits only an entity-compatible *Diagnosis* update.

System	Retrieval update	Score
M3D-CLIP retrieval	Full: replaces the complete record	0.2237
BLEU-medoid	None: text prior only	0.2915
Ours	Diagnosis only; entity-consistent	0.3134

Admission statistics (Table 5)

63.3%

blocked candidates
(31 / 49)

18 / 49

admitted
(36.7%)

Table 5. Admission trace over the 49 public-validation cases. Conflict denotes an FDI or ICD entity absent from the prior. The gate row is degenerate at $k = 1$.

Stage / conflict	Cases	%
Retrieved evidence	49	100.0
Gate passed	49	100.0
Blocked: FDI only	6	12.2
Blocked: ICD only	16	32.7
Blocked: both	9	18.4
Final admitted	18	36.7

Final challenge result (Table 6)

2nd place

11.37 points
(attainable maximum 97.4)

Table 6. Final Task 3 leaderboard under the 100-point protocol (attainable maximum 97.4). ECCR ranks second.

Rank	Team	Diagnosis	Oral exam	Treatment	Completeness	Total
1	abc-abc	5.56	1.49	4.71	5.95	17.70
2	Ours	4.89	0.00	2.72	3.76	11.37
3	sjtut26lab-task3	5.29	0.00	3.12	1.68	10.08
4	jshen	4.50	0.00	2.07	3.50	10.06
Aspect weight		0.45	0.20	0.20	0.15	1.00

Conclusion

- ECCR combines a text prior with CBCT retrieval under governed update authority.
- Bounding *Diagnosis* updates with entity preservation enriches detail while preventing unsupported entity injection.