

Exploring the Feasibility, Validity, and Reliability of DIGEST after Maxillectomy

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Background

- A maxillectomy is an invasive surgical procedure that removes a portion of the upper jaw.
- Post-operative dysphagia after maxillectomy is a well-known complication due to:
 - Poor oral bolus control
 - Radiation history
 - Extent of surgical resection within and beyond the maxilla^{1,2}

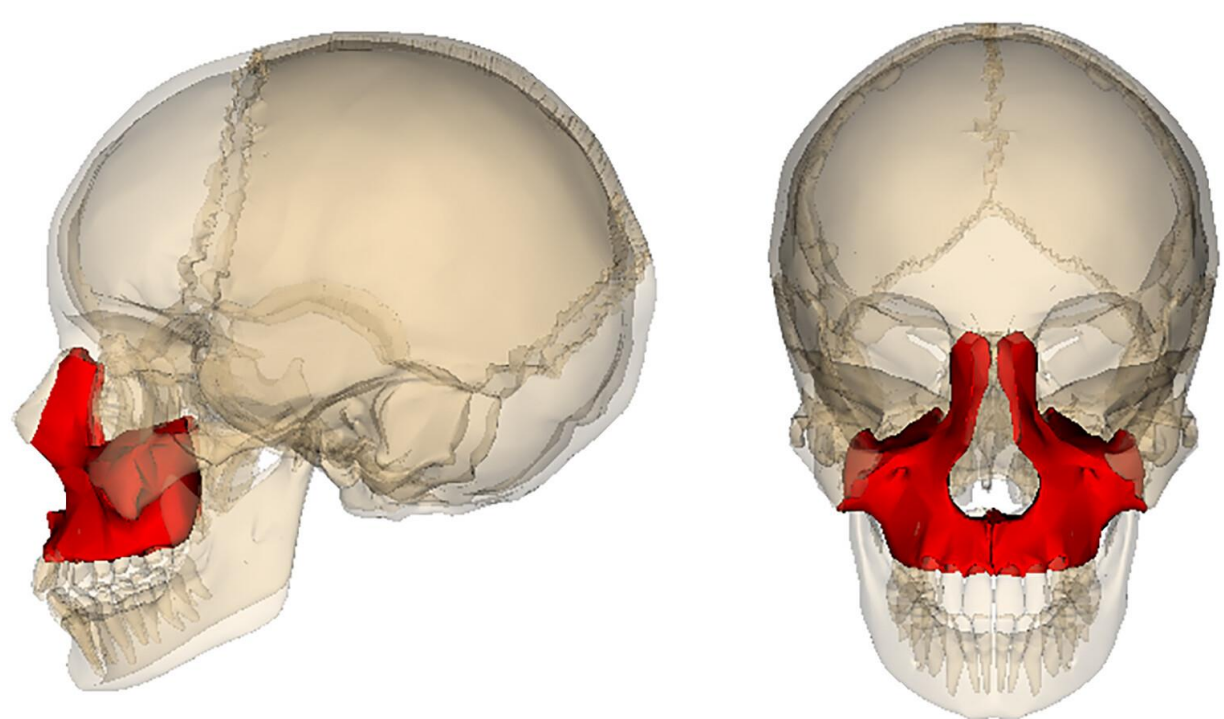


Fig. 1 Body of the maxilla



Fig. 2 Palatomaxillary defect reconstructed via free flap (left) and prosthetic obturation (right)

- Dynamic Imaging Grade of Swallowing Toxicity (DIGEST) is a validated tool to grade results of modified barium swallow studies (MBS) in head and neck cancers (HNC)³. DIGEST was initially validated to assess the pharyngeal stage of swallowing, which excluded cancers beyond the pharyngeal region.
- While DIGEST is utilized in clinical practice amongst oral cavity cancers at MD Anderson Cancer Center (MDACC), it has yet to be validated or assessed for this population. The **objective** of this study was to assess the feasibility and psychometrics of DIGEST in patients with maxillary cancer.

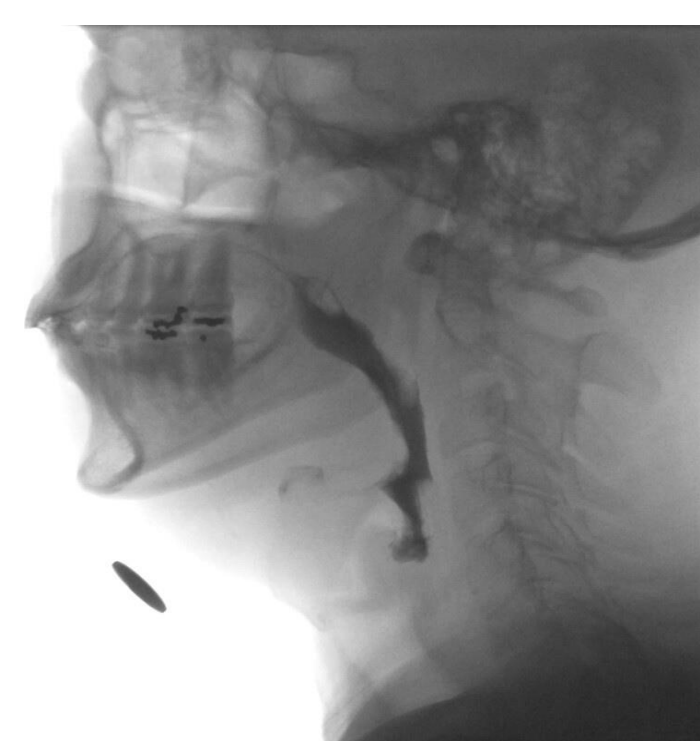


Fig. 3, modified barium swallow study thin liquid trial: no impairment

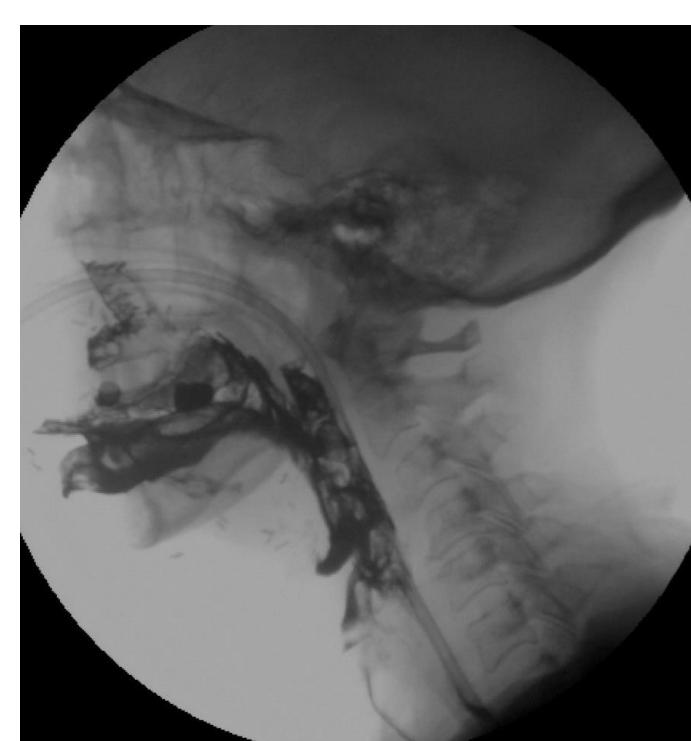


Fig. 4, modified barium swallow study thin liquid trial: severe impairment

Methods

This was a retrospective cohort study analyzing 114 patients who underwent a maxillectomy with a post-operative MBS at MDACC from 2016-2021. Measurements of criterion validity used to assess performance of DIGEST included:

- Modified Barium Swallowing Impairment Profile (**MBSImP**) oral and pharyngeal totals
- MD Anderson Dysphagia Inventory (**MDADI**) composite and physical scores
- Performance Status Scale for Head and Neck Cancer Patients (**PSS-HN**) diet

DIGEST was chart abstracted from electronic health records (EHR) then double-blind rated to assess inter-rater reliability.

Table 1, Cohort (n=114)

Sex	
Male	65 (57.0%)
Female	49 (43.0%)
Age (median)	63 (SD: 15.4)
Race	
White	95 (83.3%)
Black	7 (6.1%)
Asian	6 (5.3%)
American Indian or Alaska Native	1 (0.9%)
Native Hawaiian or Other Pacific Islander	1 (0.9%)
Other	4 (3.5%)
Cancer site	
Maxillary sinus	31 (27.2%)
Palate	26 (22.8%)
Maxilla, NOS	16 (14.0%)
Buccal mucosa	14 (12.3%)
Alveolar ridge	8 (7.0%)
Nose	5 (4.4%)
Other	14 (12.3%)
Surgical Pathology	
SCC	68 (59.7%)
ACC	12 (10.5%)
Sarcoma	9 (7.9%)
Adenocarcinoma	7 (6.1%)
Other	18 (15.8%)
Surgery Type	
Infrastructure	66 (57.9%)
Total	16 (14.0%)
Partial	16 (14.0%)
Subtotal	11 (9.0%)
Medial	5 (4.4%)
Radiation therapy	
No	14 (12.3%)
Yes	100 (87.7%)
Chemotherapy	
No	52 (45.6%)
Yes	62 (54.4%)
Reconstruction Type	
Flap	97 (85.1%)
Prosthesis	16 (14.0%)
None	1 (0.9%)

Results

- Higher MBSImP oral and pharyngeal impairment scores were seen as DIGEST increased ($r = 0.43$, $p = 0.00$; $r = 0.82$, $p = 0.00$).
- DIGEST **did not** correlate with:
 - Post-operative quality of life (MDADI)
 - Oral diet (PSS-HN)
- DIGEST was reported 95.6% of the time in EHR.
- Inter-rater reliability was substantial to almost perfect ($k = 0.75-0.87$) with blind laboratory ratings achieving >80% exact agreement.

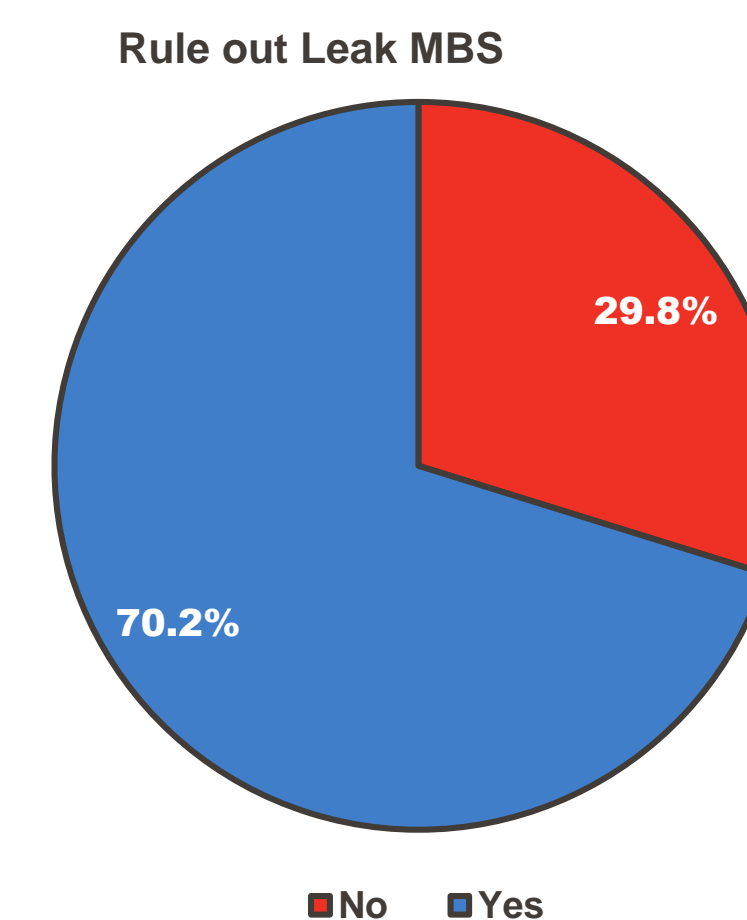
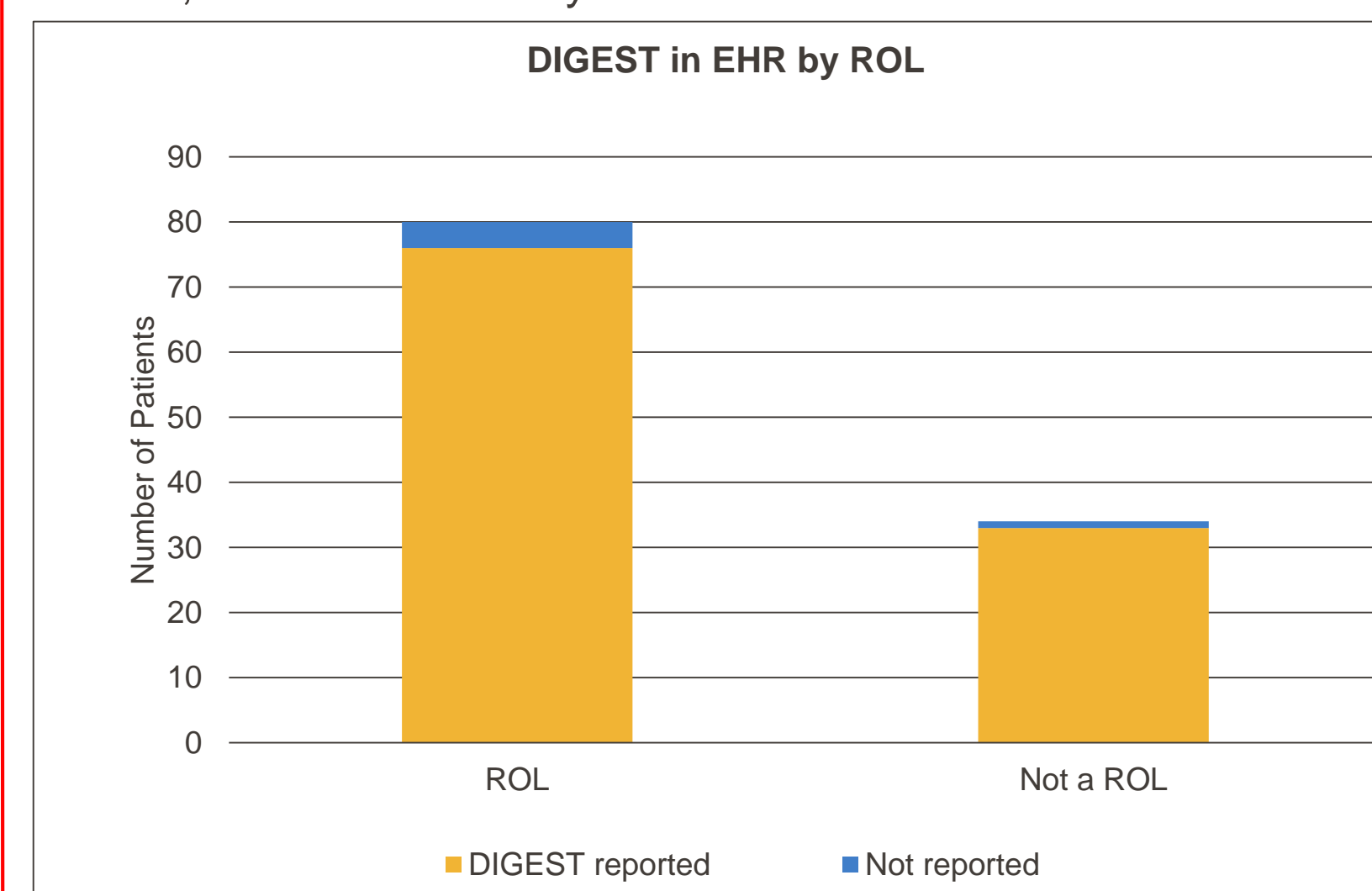


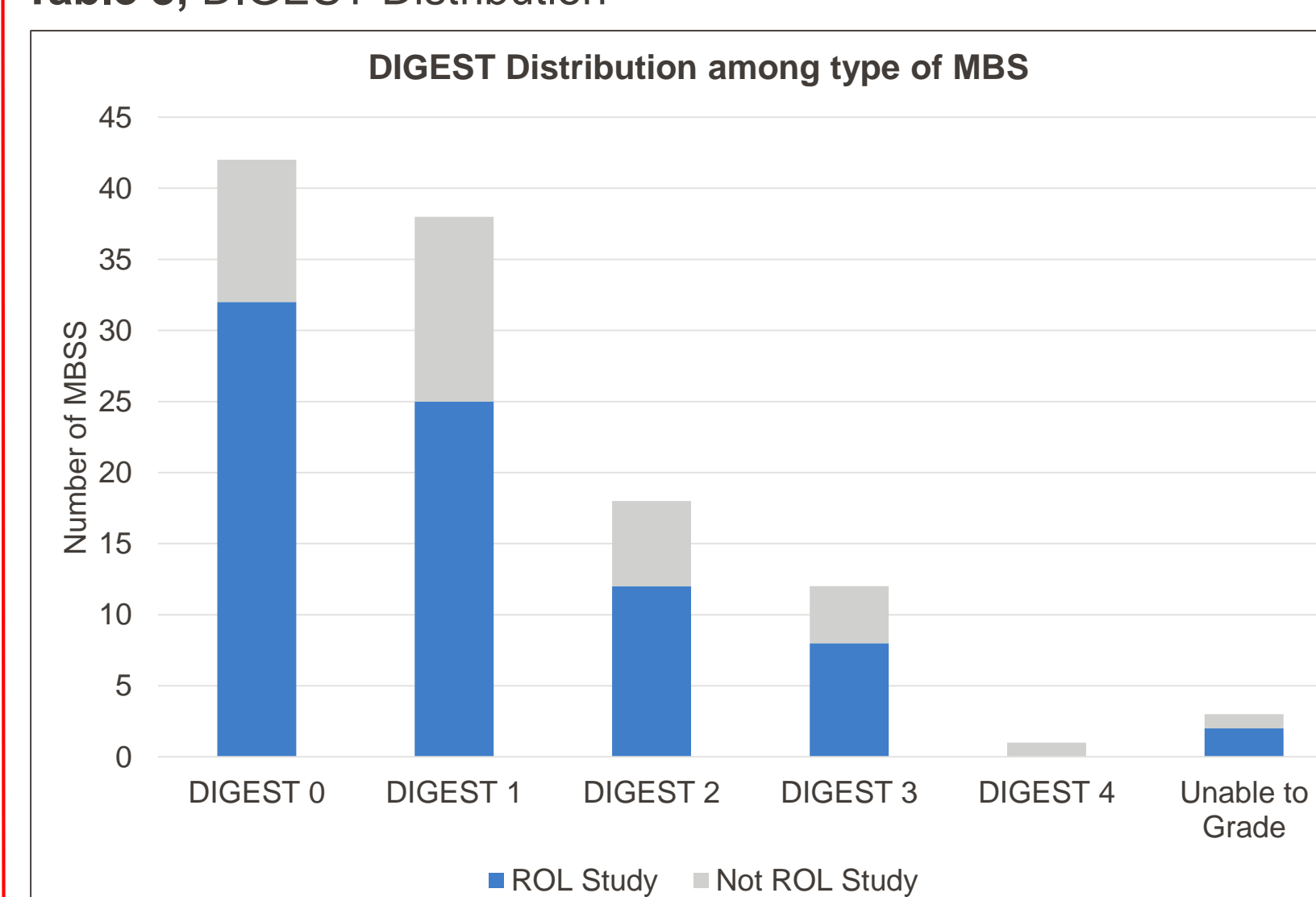
Fig. 5, A rule out leak (ROL) MBS is conducted to assess post-operative healing before oral intake. Signs of leakage will prematurely terminate the study leading to incomplete swallowing outcomes data. Patients undergoing a ROL study are typically NPO (not eating) awaiting the procedure and may or may not have symptoms of dysphagia.

Table 2, DIGEST feasibility



Bar graph revealing number of DIGEST grades reported in the EHR by ROL indication.

Table 3, DIGEST Distribution



Bar graph detailing research-graded distributions by ROL indication.

Table 4, DIGEST validation

DIGEST	MBSImP-Pharyngeal (mean) (n= 42)	MBSImP-Oral (mean) (n= 42)	MDADI-Physical (mean) (n= 25)	MDADI-Composite (mean) (n= 25)	PSSH-N Diet (mean) (n= 42)
0	3.4	5.9	73.6	74.8	17.9
1	8.3	7.6	76.9	78.5	22.4
2	13.3	9.3	63.7	68.4	9.4
3	14.1	10.5	63.5	68.0	4.2
4	18	9	-	-	0
<i>r</i> / <i>r</i> ²	0.82*	0.43*	-0.14	-0.08	-0.14

Chart displaying DIGEST validation in correlation to measurements of criterion validity.

*denotes significant p-value ($p < 0.05$)

Table 5, DIGEST Safety and Efficiency profiles

	S0	S1	S2	S3	S4	Total
E0	40	10	1	1	0	52
E1	16	12	4	6	0	38
E2	1	0	0	0	0	1
E3	7	7	2	3	0	19
E4	0	0	0	0	1	1
Total	64	29	7	10	1	111

Heat map indicating profiles of DIGEST grades. Red indicates absence, yellow signals a small presence, and green designates a heavy presence.

Table 6, DIGEST Inter-rater Reliability

Reliability	DIGEST Grade	Safety Grade	Efficiency Grade
Exact Agreement	82.6%	92.5%	86.0%
Kappa	.75*	.87**	.77*

*denotes substantial agreement

**denotes almost perfect agreement (per Landis-Koch)

Conclusions

DIGEST is a feasible and reliable tool for measuring pharyngeal dysphagia as a component of swallowing assessment after maxillectomy. DIGEST maintains validity with comparable performance to the original validation in non-oral HNC on MBS-criterion measures but not on non-MBS measures (e.g., MDADI and PSS-HN scores). Further research is needed to assess the usage of DIGEST among various populations.

References

- Denaro N, Merlano MC, Russi EG. Dysphagia in Head and Neck Cancer Patients: Pretreatment Evaluation, Predictive Factors, and Assessment during Radio-Chemotherapy, Recommendations. *Clin Exp Otorhinolaryngol*. Sep 2013;6(3):117-26. doi:10.3342/ceo.2013.6.3.117
- Ogino Y, Fujikawa N, Koga S, Moroi R, Koyano K. A retrospective cross-sectional analysis of swallowing and tongue functions in maxillectomy patients. *Support Care Cancer*. Oct 2021;29(10):6079-6085. doi:10.1007/s00520-021-06186-w
- Hutcheson KA, Barbon CEA, Alvarez CP, Warneke CL. Refining measurement of swallowing safety in the Dynamic Imaging Grade of Swallowing Toxicity (DIGEST) criteria: Validation of DIGEST version 2. *Cancer*. Apr 1 2022;128(7):1458-1466. doi:10.1002/cncr.34079