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Narrative Review

The use of videofluoroscopy (VFS) and fibreoptic endoscopic evaluation of swallowing (FEES) in the investigation of oropharyngeal dysphagia in stroke patients: A narrative review

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ABSTRACT

Objectives: Patients with suspected acute stroke require rapid assessment of swallowing on admission. If aspiration is suspected, this takes the form of specialist assessment, using either videofluoroscopy (VFS) or fibreoptic endoscopic evaluation of swallowing (FEES). The review aim was to evaluate and compare the effectiveness of each method in stroke patients. Literature was collected from the databases Scopus, Web of Science and Medline, and articles included in the review were published within the last 10 years, in the English language.

Key findings: Sensitivity and specificity ranged from 0.29–0.33 and 0.96–1.0 for VFS, respectively, and 0.37–1.0 and 0.65–0.87 for FEES, respectively, depending on the type of bolus utilised. VFS is the current gold-standard for the investigation of oropharyngeal dysphagia (OD), however, radiation dose and patient transport implications mean FEES may be preferred. FEES has limitations including 'whiteout' and the invasive nature of the endoscope. The NICE guidelines do not recommend a definitive protocol specifically in stroke patients. This suggests further research may be required to determine the most effective method.

Conclusion: FEES is a beneficial first line examination, providing limited invasiveness, and administering a high level of patient suitability, without using ionising radiation. VFS could potentially be useful following FEES to secure full visualisation, ensuring an aspiration event is not missed during FEES.

Implications for practice: Use of FEES as the first line test rather than VFS, ensures radiation dose is as low as reasonably practicable (ALARP). Ongoing research to ensure protocols follow current best practice can help ensure accurate management of oropharyngeal dysphagia in stroke patients.

Introduction

Dysphagia is a swallowing disorder characterised by difficulty in transferring a food bolus from mouth, to stomach,[1] due to structural/functional irregularities in the oral cavity, pharynx and oesophagus. Symptoms include the perception of obstruction during swallowing,[2] coughing/choking, and the sensation of food lodged in the throat.[3] Oropharyngeal dysphagia (OD) is the most common form of the disorder.

The most common cause of dysphagia is stroke/cerebrovascular accident (CVA),[4] which affects deglutition, preventing the swallowing trigger.[2] Other stroke symptoms include aphasia, apraxia and slurred speech, which can impede function.[5] Stroke is a leading cause of death in the UK, with 35,960 deaths in 2018.[6] OD incidence is 37% in acute stroke, and 78% in chronic stroke (over 6 months).[7]

Other complications of dysphagia include dehydration and malnutrition, following impaired swallowing efficacy,[8] to severely diminished deglutition with high aspirational incidence.[9,10] Aspiration pneumonia is a leading cause of mortality, accounting for 35% of post-stroke deaths.[11] Dysfunction is resolved quickly in approximately 50% of stroke-related dysphagia patients due to cortical re-organisation in the undamaged hemisphere.[12] For

Abbreviations: FEES, Fibreoptic endoscopic evaluation of swallowing; VFS, Videofluoroscopy; OD, Oropharyngeal dysphagia; CVA, Cerebrovascular Accident.

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11–50% of patients, symptoms persist for 6 or more months, this being the primary hurdle in recovery.[13,14] Consequently, a prompt diagnosis will improve patients' quality of life.

The current National Institute for Health and Care Excellence (NICE) guidelines for stroke [NG128, section 1.6][15] state visual swallow screening should occur, on admission for acute stroke.[16] Should a swallowing issue be confirmed, specialist assessment is indicated, within 24 h.[15,16] If aspiration is suspected, specialist dynamic assessment is needed[15] which takes the form of either videofluoroscopy (VFS) or fibreoptic endoscopic evaluation of swallowing (FEES)[17] (Fig. 1).[15,16]

VFS, is a modified barium swallow (MBS), using VFS equipment to provide real-time assessment/visualisation of the anatomy/physiology of swallowing.[18] It is the gold-standard in assessing OD and 'swallow safety'.[17] It can also identify aspiration/silent aspiration (aspiration with absence of cough reflex), which causes death in 20% of elderly stroke patients, within one year.[3] Varying consistencies of barium sulphate along with food are utilised; however, barium aspiration can present safety concerns.[19] Water soluble contrast agents such as Omnipaque are often the preferred option, especially those at high risk of aspiration.[19] The Royal College of Speech and Language Therapists (RCSLT) states all contrast media used in VFS must be agreed locally and documented in protocols.[19] The non-mobile aspect of VFS presents limitations and is contraindicated in those with low consciousness.[20] Additionally, The Ionising Radiation (Medical Exposure) Regulations 2017 (IR(ME)R 2017),[21] ensure benefits of ionising radiation exposures outweigh risks,[21] whilst National Diagnostic Reference Levels (NDRLs) recommend both appropriate dose area product (DAP) and fluoroscopy time.[22] As such, radiation dose in fluoroscopy should adhere to the as low as reasonably practicable (ALARP) principle.

In FEES, a fibreoptic nasopharyngo-laryngoscope assesses anatomy and potential OD[12] whilst reviewing sensory swallowing defects. Its mobile functionality makes it favourable for bed-bound stroke patients.[20] Like VFS real food is utilised, allowing a true picture of patient ability.[23] Nevertheless, FEES is invasive and can cause discomfort, epistaxis and hypotension.[24] Also, visualisation can be impaired by pharyngeal constriction, covering the endoscopic tip,[25] causing 'white-out' at the time of the swallow.[17]

Given rapid diagnosis can both minimise complications and improve patient prognosis in the case of oropharyngeal dysphagia in stroke patients, and both VFS and FEES have advantages and limitations, a narrative review was undertaken to critically analyse published literature, to evaluate and compare the effectiveness of VFS and FEES.

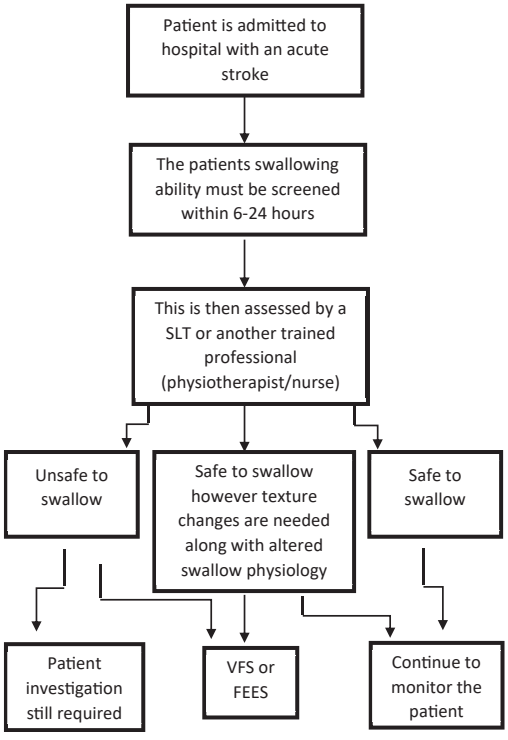

Figure 1. Screening process swallow function and oral nutrition, following patient's admission to hospital with suspected stroke adapted from the NICE guidelines.[15,16]

Methodology

A comprehensive search based on the aim and objectives, was performed using the databases Medline, Scopus, and Web of Science, whilst utilising Medical Subject Headings (MeSH), to identify extensive, high-quality literature.

The initial search was refined to include literature within last 10 years. The extent of yield meant further inclusion and exclusion criteria were implemented, to ensure relevancy to the objectives.[26] Inclusion criteria included peer reviewed articles in English, whilst research involving patients with other comorbidities and paediatrics along with articles for which full text was unavailable were excluded.

The Preferred Reporting Items for Systematic Reviews and Meta-Analysis (PRISMA) flowchart (Fig. 2) was used to organise the search strategy, demonstrating the number of identified records, and exclusions after appraisal of the title and abstract.

The literature was further screened by reading full-text articles, to ensure relevancy. A reference management table was employed to organise and evaluate data. The Critical Appraisal Skills Programme (CASP) Tool was used to evaluate research studies.

While this was a narrative review (NR), a systematic approach was utilised throughout, allowing the strength of evidence to be established, providing a structured search and evaluation and reducing the risk of potential expert bias.

Literature review

Aspiration

The Penetration-Aspiration Scale (PAS) (Table 1) is an 8-point scoring system used during VFS[27–30] and adapted for FEES examinations.[31,32] It is designed to identify depth of airway invasion, swallow remnants and patient aspiration response.[29] Training is needed to ensure similarity in categorisation between clinicians.[29]

In the detection of penetration and aspiration, FEES is thought superior in comparison to VFS,[23,33–35] although individual operator opinions differ. Fattori et al.[23] state FEES is useful at detecting aspiration; nonetheless, Adachi, Umezaki and Kikuchi[34] express FEES to be the most invasive for evaluating aspiration, due to the invasive nature of endoscopy.

In FEES, loss of visualisation can occur amid swallowing, due to the aforementioned 'whiteout', limiting review of swallowing function. Langmore[27] states most aspirations occur during swallowing, inferring this limited visualisation could impact accuracy of diagnosis. Yoon et al.[25] however, only identifies 7% of aspirations occur during swallowing, suggesting the investigation of OD would benefit from utilising FEES, in addition to VFS. For stroke patients, this may aid rapid diagnosis and treatment, preventing further deterioration of symptoms.

Sensitivity and specificity

A study[23] involving 60 patients (including 34 with neurogenic dysphagia) investigated the overall sensitivity and specificity

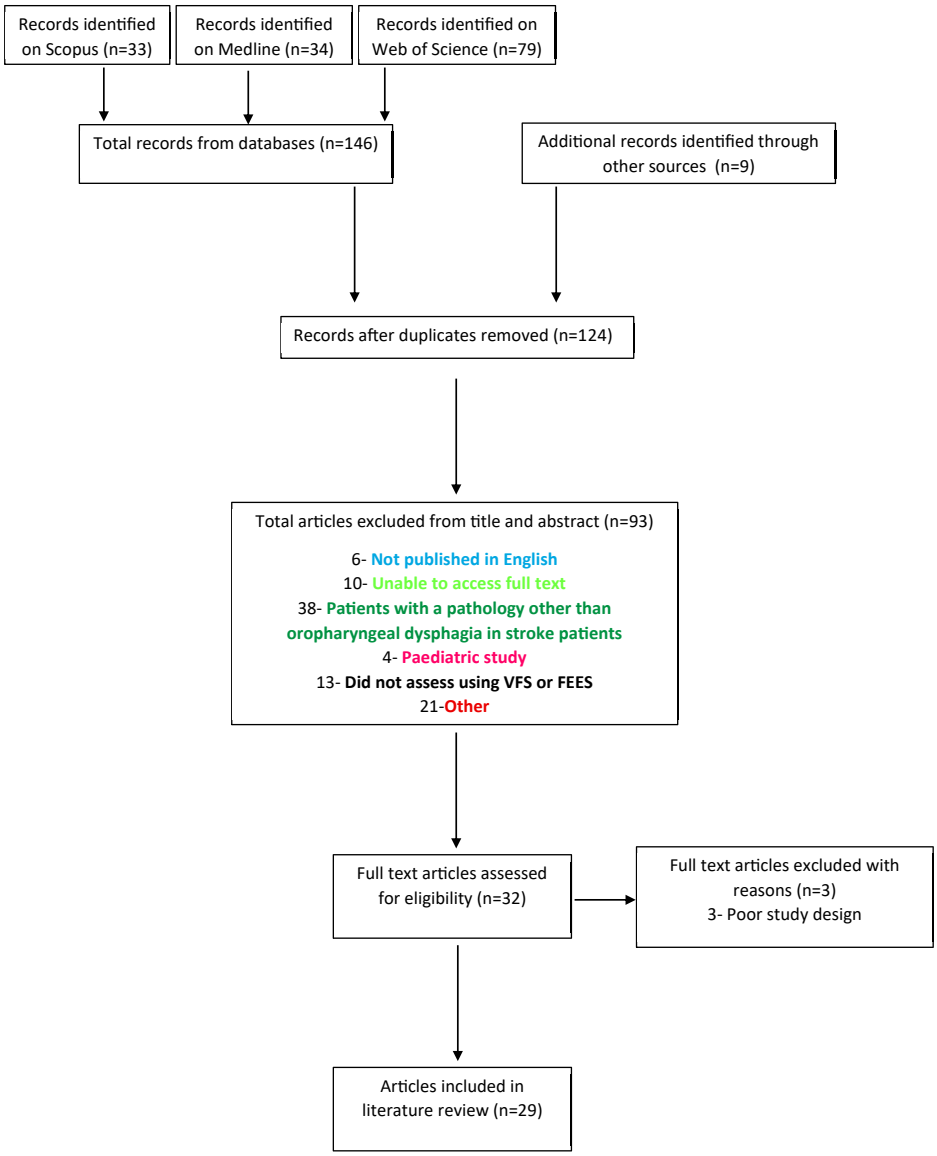

Figure 2. The Preferred Reporting Items for Systematic Reviews and Meta-Analysis (PRISMA) diagram to visualise the process of filtering search results.

Table 1
Eight-Point Penetration Aspiration Scale (PAS) demonstrating the levels at which a patients swallowing function could be scored during VFS.[39,9]

1	Material does not enter airway
2	Material enters the airway, remains above the vocal folds, and is ejected from the airway
3	Material enters the airway, remains above the vocal folds, and is not ejected from the airway
4	Material enters the airway, contacts the vocal folds, and is ejected from the airway
5	Material enters the airway, contacts the vocal folds, and is not ejected from the airway
6	Material enters the airway, passes below the vocal folds, and is ejected into the larynx or out of the airway
7	Material enters the airway, passes below the vocal folds, and is not ejected from the trachea despite effort
8	Material enters the airway, passes below the vocal folds, and no effort is made to eject

(S + S) of FEES in differing boli, presenting almost identical sensitivity values, with 0.85 in semi-solid and 0.84 in liquid boli (Table 2). This indicates bolus type does not affect overall OD detection using FEES, suggesting patients who cannot tolerate certain consistencies will not receive a poorer quality examination solely due to differing bolus. The specificity however, ranges, with 0.66 for semi-solid and 0.77 for liquid boli. This suggests the ability to rule-out pathology is affected by bolus type. Although this study has a relatively large sample size, there is limited literature available on sensitivity and specificity, and lack of VFS investigation in this study, inhibits direct examination comparisons.

For aspiration alone (Table 2) FEES sensitivity values are similar for semi-solid and liquid boli,[23] at 0.33 and 0.37 respectively, with identical specificities (0.87). This implies bolus type does not have a significant effect on aspiration detection, such that exam performance is not compromised with differing boli. Whilst the detection rate is quite low overall, the specificity remains quite high.

Table 2
The sensitivity and specificity values in FEES, when VFS was used as the reference standard using semi-solid boluses. These values are based on the overall sensitivity and specificity values of the examination type and the values based on how effective the method is at identifying aspiration.[23,33]

Type of bolus	Author	Type of Evaluation	Index test	Reference standard	Sensitivity	Specificity
Semi-solid boluses	Fattori 2016[23]	Overall	FEES	VFS	0.85	0.66
Semi-solid boluses	Fattori 2016[23]	Aspiration	FEES	VFS	0.33	0.87
Liquid boluses	Fattori 2016[23]	Overall	FEES	VFS	0.84	0.77
Liquid boluses	Fattori 2016[23]	Aspiration	FEES	VFS	0.37	0.87
Liquid boluses	Park 2015[33]	Aspiration thick liquids	FEES	VFS	1.0	0.78
Liquid boluses	Park 2015[33]	Aspiration thin liquids	FEES	VFS	0.83	0.65
Liquid boluses	Park 2015[33]	Aspiration thick liquids	VFS	FEES	0.33	1.0
Liquid boluses	Park 2015[33]	Aspiration thin liquids	VFS	FEES	0.29	0.96

Additionally, Park et al.[33] identified a sensitivity of 1.0 and 0.83 for thick and thin liquids respectively (Table 2), implying FEES accurately identified aspiration 100% of the time for thick liquids. Fattori et al.[23] however, outline low sensitivities of 0.33 for semi-solid and 0.37 for liquid boli (Table 2), preventing a definitive conclusion regarding sensitivity and specificity from these two studies. The differences in methodology between these studies are outlined in Table 3. Further studies analysing sensitivity and specificity may be needed to confirm accuracy.

VFS being the gold-standard for identifying OD, suggests it would portray high sensitivity and specificity. Park et al.,[33] however, identified low sensitivity for aspiration in both thick and thin liquids (0.33 and 0.29 retrospectively) (Table 2), questioning whether VFS should be used in isolation for identifying aspiration. This further suggests a combined use of VFS, and FEES is more beneficial, especially as the specificity for thick and thin liquids with VFS were 1.0 and 0.96 respectively. Indeed, combined techniques greatly increase the detection of aspiration when compared with VFS alone. This is demonstrated in both viscous food and liquid food (Table 4), with a statistically significant ($p < 0.001$) increase seen in combining VFS and FEES compared to VFS alone.[33] Given rapid treatment implementation is particularly important following stroke, to prevent aspiration pneumonia,[11] combined techniques are beneficial, although it is worth noting that detection rates for viscous food and liquid food for combined techniques, at 0.3 and 0.45 are still relatively low. However, imaging is only a 'snapshot' of time and not all aspiration events may be observed.

Care is also needed in extrapolating the findings of this single study, in addition to the limitation of only two boli being employed.

Table 4
Rates of detection of aspiration by videofluoroscopy (VFS) and fibreoptic endoscopic evaluation of swallowing (FEES). Identified using both viscous and liquid foods.[33]

Variable	Aspiration		
	VFS	VFS and FEES	p-value
Viscous food	5/50 (0.10)	15/50 (0.30)	<0.001
Liquid food	6/40 (0.15)	18/40 (0.45)	<0.001

Additionally, VFS and FEES were not executed consecutively, however FEES was carried out within 24 h of VFS.[33]

The literature reviewed demonstrates both VFS and FEES are valuable techniques in the investigation of OD in stroke patients. The low sensitivity value of 0.33 for aspiration detection in VFS,[23] compared to 1.0 for FEES[33] suggests that using FEES and VFS in combination, greatly increases aspiration detection, compared to VFS alone. This is beneficial for stroke patients, to provide rapid diagnosis and treatment hence, minimising risk of further symptoms and complications.

These findings could be helpful, given the current NICE guideline NG128 stroke pathway (section 1.6)[15], does not recommend a specific technique. As studies evaluating sensitivity and specificity are limited, further research is required to ensure implementation of the most beneficial examination, to increase aspiration detection, ensuring patient safety. The limited specific direction as to method of imaging within the guidance, may lead to differing procedures and prognoses for patients; further research in this area could potentially inform future guidelines to make the post-stroke swallowing assessment more informative.

Table 3
Comparison of two study methods[23,33] evaluating sensitivity and specificity of VFS and FEES.

	Fattori et al.[23]	Park et al.[33]
Patient type	Dysphagic patients of mean time period 1.5 years	Patients suspected of OD
Sample size	60 dysphagic patients (34 of these neurological dysphagia)	73 of which 23 were excluded.
Methodology	Initial test was always FEES. VFS was initially used as a reference standard because it is the gold standard test. However, FEES was also used as a reference standard. The operators were blinded to the results of the previous tests.	Both VFS and FEES performed on the same day. VFS performed initially and FEES within 24 h by an endoscopist blinded to the VFS outcome.
How thick/thin liquids are defined	**FEES** Utilised two or more semi-solid (jellied drink) or liquid boluses for each patient (water mixed with methylene blue for easier detection). **VFS** Utilised 98.45% barium sulphate contrast, diluted in 65 ml water to create a liquid consistency and in 30 ml water to create a semi-solid bolus. For both densities the patient took three sips of 5 cc.	**FEES** 5-ml yogurt was used for viscous food followed by 5 ml indigocarmine dye-mixed water for liquid food. **VFS** 5 ml liquid barium (barium sulphate) blended yogurt was used for semi-solid food representation, followed by 5 ml liquid barium diluted with water for the liquid bolus.
Amount used in each sample	5cc (5 ml)	5 ml

Patient safety

FEES

Epistaxis and bradycardia are associated complications but only occur in a small number of cases (1–2%)[33,24,27] and are mostly self-limiting, requiring no intervention.[27] While stroke patients are a high-risk group for epistaxis, the minimal impact was demonstrated by Langmore,[27] who reported no special treatment was required, two days following FEES, in 300 acute, severe stroke patients. Similarly, as FEES does not produce radiation, it can be repeated for patient dysphagia follow up throughout rehabilitation.[36,37] Zhang et al.[37] found that FEES carried out 1 month after rehabilitation could detect slight changes in the swallowing process and therefore comparisons can be made with the initial FEES test.

Although FEES is mostly tolerated, many patients find endoscope insertion very uncomfortable, negatively impacting the evaluation.[38] Lidocaine, (or similar) applied to the nares, anaesthetises the area before endoscope insertion.[38–40,32] Langmore[27] supports this, reporting increased patient comfort. However, Curtis[41] states negative effects to swallowing function are evident. This may be a result of many patients initially having minimal swallowing dysfunction, which is a limitation of this study. However, the negative impact on swallowing does not justify the non-use of anaesthesia.[38] This study does, however, only have a small sample size n = 39[41], along with a non-blinded approach to anaesthesia application. Consequently, the reported improved patient comfort may be psychological.[38] Additionally, researchers were not blinded to the study and therefore this could further add to study bias. Nonetheless, the RCSLT,[42] states FEES should be performed without anaesthesia, as it may endanger the sensory aspects of the swallow, exacerbating aspiration risk.

In a study by Dziewas,[24] which considered safety aspects of FEES, 70% of patients, reported the procedure as 'not uncomfortable/mildly uncomfortable'. However, the use of topical anaesthesia use was not specifically mentioned, which is a limitation in these results, in establishing whether tolerability of the procedure depends on the use of anaesthesia.

There is a differing opinion, relating to the amount of anaesthesia required to significantly improve patient comfort, without hindering swallowing ability. O'Dea[39] identified 0.2 ml lidocaine showed no difference in swallowing on the PAS, based on patients being tested in both anaesthetised and non-anaesthetised conditions. Accordingly, patient comfort significantly increased and the RCSLT[42] acknowledges this, yet suggests use should be avoided until further evidence emerges. An alternative adopted by Nordio et al.[7] was to use a water-soluble lubricant to minimise patient discomfort with pureed and liquid boli; unfortunately, no assessment with solid swallowing was made. Whilst no outcome measures of patient comfort were obtained, this does outline alternative approaches are feasible.

One of the main issues identified with FEES, is the result of 'whiteout', occurring due to swallowed material covering the tip of the endoscope which can consequently result in an aspiration event.[17] With the lack of consensus in anaesthesia usage, further research is required and the RCSLT[42] supports this, stating FEES should be performed without anaesthesia to ensure aspiration is not increased until further evidence emerges. This could then however mean some patients cannot tolerate FEES, so the benefits of utilising both VFS and FEES remains.

VFS

Monitoring of radiation exposure is essential throughout VFS, to comply with IR(ME)R 2017 and the Ionising Radiation Regulations 2017 (IRR17), keeping radiation exposure as low as reasonably practicable (ALARP), to minimise excessive or incorrect exposures.[21,43] Reducing fluoroscopy exposure time is a further safety measure during VFS.[44] Similarly, NDRLs are implemented to keep exposure ALARP.[22,45] They may however be exceeded for certain exceptions, (patient diagnosis, or complexity of the procedure).[45] Whilst examinations in stroke patients may exceed the NDRLs, the operator still has a legal responsibility to comply with IR(ME)R2017.[21]

VFS can be operated in pulsed mode either at 15 pulses per second (pps), or 30 pps which is generally referred to as continuous mode,[46] the latter produces a higher dose. This has been associated with increased patient cancer risk,[47] however, the VFS benefits may outweigh this risk. This is particularly relevant for stroke patients, where radiation is not the primary concern, due to critical urgency in diagnosing swallowing severity, preventing worsening symptoms and commencing treatment promptly.[20]

Some clinicians assume associated cancer risks are too high, lowering the pulse rate significantly. This reduces dose but has a negative impact on diagnostic accuracy.[47] Fluoroscopy can be switched from 30pps to 15pps, reducing radiation dose by 22%.[46] However, it has been found VFS should not be performed lower than 15pps, as the presence and extent of aspiration visualisation may be impaired, with some occurring in less than 1 s.[46,47] The benefit of the detailed swallowing action captured in 30pps is seen to be preferred. Moreover, Kim et al.[48] reported a patient has to undergo over 15 VFS per year to exceed the annual patient radiation dose limit of 20 mSv which is very rare, therefore radiation risks from this procedure are low.[43]

Kim et al.,[48] identified a significant difference between DAP and screening time in patients with CNS lesions, including stroke, compared to those without this comorbidity. Longer exposure times, (resulting in higher NRDLs) are necessary to determine the impact of the effects of stroke (such as aphasia/apraxia) on swallowing function. The benefit of visualisation even with the higher NRDLs, evident from the increased screening time/radiation dose, does in fact lead to clear diagnosis. Although there is a large study sample (295 patients), only 30.8% were CVA patients, therefore further stroke investigations are required.[42] This study did not investigate patients' dysphagia severity and there was variation in diets, which may have resulted in increased screening time.[48]

The influence of radiographic projection on radiation dose emitted in VFS has not been extensively researched. A standard procedure obtains images in the lateral and posteroanterior (PA) projection[44,49,50] (less commonly anteroposterior [AP][48,49]). DAP varies with projection, and dose is three times larger for AP versus PA.[44] In lateral projection, the thyroid gland receives one of the highest organ radiation doses, due to its radiosensitivity and proximity to the direct beam.[51] As VFS utilises a small field of view,[50] all other organs receive limited radiation, being remote from the primary beam, minimising risk of carcinogenesis.[51]

For stroke patients it must be identified whether the benefits of VFS outweigh the risks. VFS is the gold-standard examination, yet the main drawback identified, is the associated use of ionising radiation. The NDRLs, should be adhered to where possible, however, there are exceptions, particularly in stroke patients, where diagnosis and rapid treatment are required, to prevent aspiration pneumonia. Furthermore, the literature does not emphasise the importance of the NDRLs, and VFS guidelines set by the RCSLT[19] do not mention this in operator training. This may be due to the important diagnostic benefit of VFS for stroke patients, justifying the additional radiation dose. Therefore, the findings of the current review suggest, further NDRL investigation may not be necessary, however, the dose should be ALARP in line with IR(ME)R2017.[21] In addition, if VFS is utilised, avoiding use of equipment orientated to an AP position is beneficial, due to higher dose implication. Dose

surveys should be implemented and checked regularly to ensure the dose is ALARP.

Marques, Abrahão-Júnior and Lemme[30] outlined that although VFS uses radiation, images are saved to allow future review, preventing additional radiation exposure.[30]

Longer swallowing times are evident with stroke patients because of potential inability to respond to instruction quickly. This causes lengthier screening times, consequently increasing radiation dose.[48] The increased risk of aspiration negates encouraging the patient to swallow faster. Additionally, VFS can be limited in stroke patients as it cannot be performed on those who cannot remain upright.[33] Furthermore,the requirement for patient transport to the radiology department for VFS, means that for many stroke patients, FEES should be the first line of investigation, as it is more 'patient-friendly,' given it can be performed at the bedside.[52]

If the cause of OD still cannot be determined and more information is required, VFS could be performed. There is limited research on the benefits of both VFS and FEES, specifically for stroke patients, therefore, additional studies may be required for this patient aetiology.

VFS also presents a radiation safety concern for the operator, this is an acceptable limit however radiation protection strategies should be in place to keep the dose ALARP. Operators generally wear a lead apron and must wear a thermoluminescent dosimeter (TLD) underneath to detect radiation dose levels.[43,49] The operator should aim to increase their distance from fluoroscopy equipment to ensure the dose is ALARP.[43]

Limitations

It is important to note the limitations of this review, in relation to inclusion and exclusion criteria. The literature search was limited to a period of ten years, meaning some relevant results which existed outside of the timeframe were discounted. Secondly, lack of translation devices meant literature in other languages was omitted, subsequently constraining the review. Conclusions regarding sensitivity and specificity of VFS and FEES, were restricted due to limited comparison evident within the studies sourced. Similarly, this work reviewed imaging modalities used in the management of OD in stroke patients and is not as stringent as a systematic review.

Going forward, new techniques such as static endoscopic evaluation of swallowing (SEES) could be investigated further. This method can improve efficacy of swallowing evaluation by performing endoscopy before and after swallowing to identify potential safety issues and further determine instrumental workup.[17] It is intended to supplement a swallowing evaluation, rather than replace VFS or FEES.[41] SEES has been found to detect aspiration more frequently than VFS, providing a higher sensitivity, identified by Chang et al. as 0.67[53] compared to Park et al. who produced a sensitivity of 0.29[33]. Therefore, if aspiration identification is required, this could rule out the need for VFS, reducing patient radiation risk, while still gaining a diagnostic result.

Conclusion

VFS has long been known as the 'gold-standard' due to its ability to visualise the whole aerodigestive tract. The limited invasiveness of this procedure is highly beneficial and an important factor in examination choice. It can be imperative for stroke patients, as many cannot tolerate endoscope insertion and placement. Although the literature emphasised the importance of adhering to ALARP, for stroke patients this is not a critical risk factor, when weighed against examination benefits. This should however be considered on an individual basis, to ensure the best diagnostic results are gained within an acceptable timeframe and if this is not possible, FEES could be performed instead.

More recently, FEES has gained in popularity and can be used to image stroke patients without added radiation risk. Additionally, FEES can take a bedside approach, meaning patient positioning is more easily achieved with minimal patient movement. However, it does involve invasive endoscopic insertion and can 'miss' aspiration events due to 'white out'.

These factors suggest the use of FEES, followed by VFS could be a potentially beneficial line of investigation. This approach allows for specific tailoring to each individual stroke patient, to provide an extensive and comfortable examination, whilst maximising diagnostic capability. The limited direction from NICE guidelines (NG128),[15] suggests a patient specific examination should currently be in place. However, more detailed recommendations, regarding specific stroke pathway would be helpful, to provide a rapid diagnosis, allowing for improved management of OD for stroke patients in the future.

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