Predictors, outcome and characteristics of oropharyngeal dysphagia in idiopathic inflammatory myopathy

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Abstract

Introduction: Oropharyngeal dysphagia is a clinical hallmark of idiopathic inflammatory myopathy (IIM). This study investigated predictors, outcome, and characteristics of oropharyngeal dysphagia in patients with different types of IIM.

Methods: Flexible endoscopic evaluation of swallowing (FEES) videos of 71 IIM patients were retrospectively analyzed for bolus spillage, penetration, aspiration, and pharyngeal residue. Based on these findings, dysphagia severity was rated. Regression analyses were performed to investigate demographic and disease-specific predictors of dysphagia severity and pneumonia as outcome-relevant complications of dysphagia. A score was developed to rate the quality of the endoscopic white-out as a surrogate marker for pharyngeal muscle weakness with consecutive residue.

Results: Our analysis revealed no independent predictors of dysphagia severity. Dysphagia severity, however, was an independent predictor for pneumonia, which occurred in 24% of patients. Pharyngeal residue with risk of postdeglutitive aspiration was the most common dysphagia pattern. Attenuation of the endoscopic white-out was related to residue severity.

Discussion: Dysphagia in IIM assessed with FEES is associated with relevant complications, such as aspiration pneumonia, and must be considered independently of peripheral muscle weakness and disease duration. Swallowing impairment mainly presents with pharyngeal residue. The quality of the white-out may serve as a semi-quantitative surrogate marker for pharyngeal contractility.

KEYWORDS
aspiration, dysphagia, myositis, outcome measure, pneumonia

INTRODUCTION

Idiopathic inflammatory myopathies (IIM) are a heterogeneous group of autoimmune diseases with inflammation of the skeletal muscles. Since the oropharynx and the proximal esophagus consist of skeletal
muscle tissue.\textsuperscript{1} IIMs often result in dysphagia due to inflammatory involvement of the swallowing muscles.\textsuperscript{2} In fact, dysphagia is part of the current European League Against Rheumatism (EULAR) diagnostic criteria for IIM.\textsuperscript{3} Clinically, dysphagia can lead to complications, such as weight loss or aspiration pneumonia.\textsuperscript{4}

Despite the clinical importance, studies focusing on the severity, pattern, and prognostic relevance of dysphagia in patients with IIM are rare and partly inconclusive, for example some studies report an association of dysphagia with increased mortality,\textsuperscript{5} whereas others report no worse outcome.\textsuperscript{6,7} Instrumental assessment is considered the diagnostic gold standard, especially since patients do not necessarily perceive symptoms of dysphagia\textsuperscript{8,9} and, therefore, may not report it spontaneously. Clinical assessment alone may miss relevant findings, for example, silent aspiration.\textsuperscript{10} In addition to the videofluoroscopic swallowing study (VFSS), flexible endoscopic evaluation of swallowing (FEES) is a widely used equally valid technique.\textsuperscript{11} As a low-risk procedure without exposure to radiation or contrast agents that can be performed in an ambulatory setting or at the bedside, FEES may be especially suitable for the initial evaluation of IIM patients. However, FEES-based studies of dysphagia in patients with IIM are rare,\textsuperscript{10} and some FEES-specific characteristics have not yet been investigated at all, for example white-out. At the beginning of the pharyngeal phase of swallowing, the contraction of the pharyngeal muscles causes increased intrapharyngeal pressure. As a result, the tip of the endoscope is pressed against the pharyngeal wall during FEES. This leads to white superimposition by reflection of the light from the endoscope, a phenomenon that is called white-out.\textsuperscript{12} Since reduced pharyngeal contractility is an important dysphagia mechanism in IIM,\textsuperscript{13} changes in white-out may be relevant. The aim of the present study, therefore, was to describe the typical FEES characteristics of dysphagia including white-out in patients with different types of IIM. Furthermore, this study assessed clinical and demographic predictors for dysphagia severity and the outcome of IIM patients with dysphagia.

2 | PATIENTS AND METHODS

2.1 | Patients and data collection

All patients with probable or definitive IIM according to the EULAR-criteria\textsuperscript{2} who were treated in our department (University Hospital Muenster) between 2009 and 2019 and had received FEES for diagnostic reasons were retrospectively included in this study. In accordance with our usual practice, all patients with symptoms or clinical signs of dysphagia received a FEES examination during this period. FEES was performed by a trained neurologist together with a speech-language pathologist. The following three consistencies were each tested with three swallows: 8 mL of semisolid pudding, 5 mL of blue dyed liquid, and approximately 3 × 3 × 0.5 cm solid white bread. The following clinical characteristics were noted for every patient: age, sex, diagnostic group according to the EULAR-criteria,\textsuperscript{3} disease duration, Manual-Muscle-Testing-8-score (MMT-8), presence or absence of malignancy, diagnosis of pneumonia during the 2009-2019 study period or the documented period included therein, death and cause of death during the 2009-2019 study period or the documented period included therein. The study conformed with the World Medical Association Declaration of Helsinki. It was approved by the local ethics committee (Ärztekammer Westfalen-Lippe und der Westfälischen Wilhelms-Universität: 2016-391-f-S). Since the design was completely retrospective, the ethics committee waived the need for informed consent.

2.2 | Rating of dysphagia severity

All available FEES-videos were reviewed. Each swallow was rated according to a previously published score\textsuperscript{14} (for a more detailed explanation, see section 2.5). The overall oropharyngeal dysphagia severity was then rated for each patient according to the following ordinal score: 0: no signs of dysphagia (premature bolus spillage ≤ 2, pharyngeal residue ≤ 1, penetration/aspiration = 0); 1: signs of dysphagia (ie, pharyngeal residue ≥ 2 or premature bolus spillage ≥ 3) without aspiration (≤ 2); 2: aspiration (≥ 3) of one bolus consistency; 3: aspiration (≥ 3) of multiple bolus consistencies. The rating was performed by B.L. and K.P. who were blinded to the diagnosis of the patients, but not to the previous initial FEES rating. If more than one FEES was performed on a patient, the most recent FEES video was evaluated.

2.3 | Predictors of dysphagia

To investigate predictors of dysphagia severity, an ordinal logistic regression analysis was performed with sex, diagnostic group, and presence of a malignant disease as factors and age, MMT-8-score and disease duration as covariates. The modal and its factors/covariates were considered predictive if the P-value was <.05.

2.4 | Outcome of dysphagia

A binary logistic regression model was used to investigate predictors of pneumonia and predictors of death. The following independent variables were included: sex, age, diagnostic group, dysphagia severity, MMT-8-score, disease duration, and malignancy (nominal variables were rated as dummy-variables). The models and its variables were considered predictive if the P-value was <.05.

2.5 | Characteristics of dysphagia

The following salient findings were rated on 5-point ordinal scales for every swallow based on a previously published score that rates overall swallowing function\textsuperscript{14}:

- Premature bolus spillage: 0: The bolus is behind the tongue; 1: The bolus is at the base of the tongue or in the valleculae; 2: The bolus moves to lateral channels or the tip of the epiglottis; 3: The bolus...
Clinical characteristics of the patient cohort

| Diagnostic group                  | N (%)   |
|----------------------------------|---------|
| Dermatomyositis                   | 13 (18.3%) |
| Inclusion body myositis           | 29 (40.8%) |
| Polymyositis                      | 29 (40.8%) |
| Disease duration in years         | 5.4 ± 5.8 |

| Dysphagia according to FEES       | N (%)   |
|----------------------------------|---------|
| No dysphagia                      | 5 (7.0%) |
| Without aspiration                | 44 (62.0%) |
| Aspiration of 1 consistency       | 8 (11.3%) |
| Aspiration of multiple consistencies | 14 (19.7%) |
| Mean MMT-8 score ± SD             | 129.5 ± 23.0 |
| Malignancy                        | 14 (19.7%) |
| Pneumonia                         | 17 (23.9%) |
| Death                             | 7 (9.9%) |

**3 | RESULTS**

Seventy-one patients were included in this study. The clinical characteristics of the cohort are described in Table 1.

### 3.1 | Predictors of dysphagia

We were not able to identify independent predictors of dysphagia severity with the ordinal logistic regression model (P = .07; Pearson’s chi-squared = 12.94; Nagelkerke’s R-squared = 0.19).

### 3.2 | Outcome of dysphagia

The binary logistic regression models to predict pneumonia was significant (Omnibus Chi-square = 40.79; P < .01; Nagelkerke’s R-squared = 0.67), with dysphagia severity and the presence of a malignant disease being independent predicting factors (statistics of the regression model can be seen in Table 2). The regression model to predict death was not significant (Omnibus chi-squared = 14.50; P = .07; Nagelkerke’s R-squared = 0.39).

The distribution of pneumonia incidence and death as a function of dysphagia severity can be seen in Figure 1. A total of seven patients died during the observation period. The causes of death were pneumonia with sepsis (two cases), aspiration with cardiac decompensation (one case), total parenteral nutrition with pancreatitis and multiorgan failure (one case) and metastatic urothelial carcinoma (one case). The causes of two deaths were unknown.

### 3.3 | Dysphagia characteristics

The frequency of premature bolus spillage, penetration/aspiration, and pharyngeal residue and their distribution within the different consistencies in relation to the number of patients is shown in the Supporting Information Table S51. Furthermore, the timing of penetration/aspiration events and the characteristics of repetitive swallowing in cases of pharyngeal residue in relation to the number of respective swallowing events is illustrated.

Pharyngeal residue was the most prominent dysphagia mechanism and led to postdeglutitive penetration or aspiration in about half of the patients. In the majority of cases, pharyngeal residue triggered repeated swallowing, resulting in further bolus clearance. Premature bolus spillage was less likely to result in penetration or aspiration and was most pronounced for liquid consistency.

There was a significant correlation between the completeness of the white-out and the amount of residue with lesser white-out being related to more residue [rho = −.20, P < .01]. The correlation is illustrated using a scatter plot in Figure 2. Interrater reliability for the white-out score was [rho = .88, P < .01].

**TABLE 1**Clinical characteristics of the patient cohort

| Mean age in years ± SD | 67.8 ± 12.7 |
| Sex men, N (%)         | 36 (50.7%) |
| Diagnostic group       |           |
| Dermatomyositis        | 13 (18.3%) |
| Inclusion body myositis| 29 (40.8%) |
| Polymyositis           | 29 (40.8%) |
| Disease duration in years | 5.4 ± 5.8 |

Dysphagia according to FEES

| No dysphagia                      | 5 (7.0%) |
| Without aspiration                | 44 (62.0%) |
| Aspiration of 1 consistency       | 8 (11.3%) |
| Aspiration of multiple consistencies | 14 (19.7%) |
| Mean MMT-8 score ± SD             | 129.5 ± 23.0 |
| Malignancy                        | 14 (19.7%) |
| Pneumonia                         | 17 (23.9%) |
| Death                             | 7 (9.9%) |
DISCUSSION

The results from our study show that oropharyngeal dysphagia in IIM assessed with FEES is a complication-prone symptom leading to aspiration pneumonia. Clinical predictors or general markers of IIM disease severity do not appear to be predictive of dysphagia. These results are supported by the findings of Kim et al. in patients with dermatomyositis who found no correlation between kinematic data of the laryngeal structures assessed with VFSS and the strength of limb muscles. McCann et al. also found no correlation between swallowing function and muscle strength in patients with juvenile dermatomyositis. In addition, there are various reports of patients with

| Independent factor     | P-Value | Beta coefficient | Exponential beta (95% CI) |
|------------------------|---------|-----------------|--------------------------|
| Sex (men)\textsuperscript{a} | .26     | 1.03            | 3.53 (0.46-16.89)         |
| Age                    | .44     | -0.03           | 0.97 (0.89-1.05)          |
| Diagnostic group\textsuperscript{b} | .24     |                 |                          |
| Dermatomyositis        | .61     | 0.70            | 2.02 (0.13-30.54)         |
| Polymyositis           | .10     | 2.21            | 9.14 (0.67-124.76)        |
| Dysphagia severity     | < .01   | 2.47            | 11.79 (3.23-42.99)        |
| MMT-8                  | .69     | -0.01           | 0.99 (0.95-1.03)          |
| Disease duration       | .40     | 0.08            | 1.08 (0.90-1.30)          |
| Malignancy (absence)\textsuperscript{c} | .02     | -2.72           | 0.07 (0.01-0.60)          |

\textsuperscript{a}Women as reference.
\textsuperscript{b}Inclusion body myositis as reference.
\textsuperscript{c}Presence of a malignant disease as reference.

FIGURE 1 Incidence of pneumonia and death in % as a function of dysphagia severity [Color figure can be viewed at wileyonlinelibrary.com]

FIGURE 2 Scatter plot illustrating the correlation between white-out (x-axis) and residue severity (y-axis)
dysphagia as initial or only manifestation of IIM without symptoms of limb muscle involvement.16,17 Thus, the extent of general muscle weakness and the disease duration do not seem to provide information on swallowing function, so that dysphagia must be considered independently of these factors. Here, myositis-related dysphagia differs from other forms of neurogenic dysphagia, such as stroke-related dysphagia, which correlates with general stroke symptoms and severity.18 However, in contrast to the results of this study, there are other studies suggesting that dysphagia is associated with certain clinical parameters, for example, that the prevalence of dysphagia in inclusion body myositis is particularly high compared to other forms of IIM.13

The association of dysphagia severity with pneumonia is in line with the results of previous studies4,5,9,19,20 and underlines both the clinical relevance of dysphagia and the validity of FEES findings. Although dysphagia severity was not statistically significant in predicting death, 43% of deaths in our cohort are assumed to be causally related to dysphagia. Therefore, dysphagia may have an impact on mortality despite the insignificant results in our study, which might have been due to the sample size. This hypothesis would be consistent with the results of a survey-based study of 734 patient cases with inclusion body myositis in which physicians reported that patients with dysphagia had a shortened lifespan. The majority of physicians reported dysphagia as the primary source of premature mortality.21

Pharyngeal residue was the main dysphagia phenotype. In most cases, penetration and aspiration occurred postdeglutively, that is due to residue overflow into the laryngeal vestibule. Predeglutitive events due to premature bolus spillage, in contrast, occurred less frequently and if so, mainly with liquid consistencies. Oral impairment, therefore, may occur in IIM but is of secondary importance regarding penetration/aspiration compared to pharyngeal impairment. This is in line with a study of patients with inclusion body myositis in which physicians reported that patients with dysphagia had a shortened lifespan. The majority of physicians reported dysphagia as the primary source of premature mortality.21

Pharyngeal residue may partly be caused by reduced pharyngeal contractility.13,22 The gold standard for the analysis of intrapharyngeal pressure is pharyngeal manometry.23 However, its availability in routine clinical practice is limited and therefore contractility parameters in clinically more established swallowing diagnostics are needed. As a FEES-parameter, the pharyngeal squeeze manoeuvre has been suggested, in which pharyngeal contractility during forced vocalization is assessed as normal or attenuated.24 The white-out score proposed in this study represents an extension of this approach by focussing on involuntary contractility during swallowing. The duration of white-out, defined as the period during which the laryngeal structures are no longer visible, has been used to assess the duration of the pharyngeal phase of swallowing, for example as a parameter for pharyngeal bradykinesia in Parkinson’s disease.25 However, since in this study we aimed at measuring the vigor of the pharyngeal contraction, a different approach was established: Instead of determining the time period in which the laryngeal structures were no longer visible, the proportion of white superimposition in the frame with maximum contractility was ordinally scaled. The rationale for this approach was that even with weakened contractility, laryngeal structures can be obscured by incomplete superimposition, so that the mere period of non-visible structures may not be significant in terms of contractility. We, therefore, hypothesized that pharyngeal contractility could be evaluated by characterizing the white-out observed in the frame with maximum contractility within FEES. The highly significant, albeit weak inverse correlation between the white-out score and the severity of residue could possibly be seen as an indication supporting these considerations. However, since no direct pharyngeal pressure measurements were performed in this study, the association of white-out and contractility is based solely on pathophysiological considerations and must therefore be considered speculative. The weak correlation between white-out and residue may be explained by other factors that contribute to residue in addition to reduced pharyngeal contractility: A further prerequisite for sufficient bolus clearance is adequate relaxation of the upper esophageal sphincter (UES).26 Various authors reported relaxation disorders of the UES due to cricopharyngeal dysfunction in IIM.8,13,27,28 Pharyngeal residue in IIM thus seems to result from an interaction between reduced pharyngeal contractility and impaired opening of the UES.26 In addition, reduced contractility of the suprathyroid musculature and consequently a decreased laryngeal elevation could play a role.13,29,33

Our data show that often repetitive clearing swallows occurred if pharyngeal residue were present. Thus, in contrast to other neurological disease conditions such as post-intubation dysphagia, stroke, or Parkinson’s disease,34 pharyngeal sensation in myositis seems to be intact so that a sensory stimulus caused by pharyngeal residue triggers further swallowing as a spontaneous compensatory mechanism. This could be considered in behavioral swallowing therapy for myositis, for example, by focusing on techniques based on sensory feedback. Also other studies describe repetitive swallowing27 or piecemeal deglutition28,35 in patients with IIM. In this context, Ertekin et al. used the amount of maximal bolus volume without piecemeal deglution as parameter for dysphagia limit.28,35 Conversely, piecewise swallowing could also be seen as a compensatory mechanism to reduce pharyngeal residue.

When interpreting the results of this study, several limitations must be considered. The retrospective design has led to a selection bias. Patients were only included if they received a diagnostic FEES due to symptoms or clinical signs of dysphagia, so the cohort is not representative of all patients with IIM. Not all patients were treated at our clinic during the entire study period (2009-2019), and for some patients, there were gaps in the documentation. Due to our outpatient dysphagia clinic, patients with swallowing disorders are often referred to our facility, which may have further biased the results by increasing the proportion of patients with particularly severe dysphagia. Only a few patients in our cohort had no dysphagia. This could have affected the analysis of predictors of dysphagia: there may be clinical predictors that distinguish between dysphagic and nondysphagic patients (as suggested by other studies13), which may not be significant in this analysis due to the small number of nondysphagic patients. The division of IIM into subgroups is subject to
constant discussion. This study used the current EULAR-criteria to differentiate between dermatomyositis, inclusion body myositis and, as an exclusion diagnosis, polymyositis. Other authors, however, differentiate further subgroups, which are grouped together as polymyositis in this study. FEES was terminated early if aspiration events indicated that further examination was not safe for the patient. As a result, solid consistencies were examined less frequently, as patients with severely impaired swallowing function dropped out of the analysis. When analyzing the white-out, the light source and the position of the endoscope are presumably influencing factors. Furthermore, the association of white-out with pharyngeal contractility is based on pathophysiological considerations. Further studies with simultaneous FEES and pharyngeal pressure assessment, therefore, are necessary to prove the association.

In summary, our study shows that dysphagia in IIM can be validly assessed with FEES, must be considered early in the course of the disease and regardless of peripheral muscle weakness, and is associated with life-threatening complications, such as pneumonia. Pharyngeal residue after swallowing is the main dysphagia mechanism and imposes a risk of penetration into the larynx. Residue are related to reduced pharyngeal contractility. Repetitive swallowing as a spontaneous compensatory mechanism can improve bolus clearance.

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CONFLICT OF INTEREST
None of the authors has any conflict of interest to disclose.

DATA AVAILABILITY STATEMENT
Due to data protection by the ethics committee, patient data are limited to the persons involved in the study. Data can only be provided in anonymized form.

ETHICAL PUBLICATION STATEMENT
We confirm that we have read the Journal’s position on issues involved in ethical publication and affirm that this report is consistent with those guidelines.

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**SUPPORTING INFORMATION**

Additional supporting information may be found online in the Supporting Information section at the end of this article.

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