Review Article

A Review: Mealtime Difficulties following Frontotemporal Lobar Degeneration

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Keywords

Frontotemporal dementia · Neurodegeneration · Dysphagia · Eating behavior · Primary progressive aphasia · Corticobasal degeneration · Progressive supranuclear palsy

Abstract

Background: Frontotemporal lobar degeneration (FTLD) can result in a decline in behavior, language, and motor function. Mealtime disturbances are a common and significant outcome of FTLD. Disturbances during mealtimes can arise from dysphagia or may occur secondary to behavioral changes such as rapid eating, mealtime rigidity, and altered diet preferences. **Summary:** Few studies have comprehensively evaluated eating behavior or dysphagia in individuals presenting with FTLD pathology despite the potential impact on medical safety and individual quality of life. Dysphagia is reported in the late stages of frontotemporal dementia and early in the motor subtypes of FTLD. The identification of dysphagia can alert individuals and medical teams to disease progression and provide insight into the nature and spread of the underlying neuropathology. Improved understanding of eating behaviors can improve individual care and may enhance diagnostic accuracy. **Key Message:** Aberrant eating behavior and swallowing difficulties are reported in the conditions associated with FTLD neuropathology. The consequences of mealtime disturbances include health risks associated with an increased BMI and aspiration, reduction of an individual's independence, and an increase in caregiver stress and burden. Here we review and summarize the literature on eating behavior and swallow impairments (dysphagia) in each of the syndromes caused by FTLD.

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Introduction

Frontotemporal lobar degeneration (FTLD) refers to the underlying pathological profile of a group of neurodegenerative disorders where progressive atrophy occurs in the frontal or temporal lobes of the brain. Consequences of FTLD include a decline in behavior, language, and motor function [1]. Mealtime disturbances are thought to be common sequelae of the neuropathology. Anecdotal reports describe individuals with insatiable appetite, altered food preferences, and dysphagia exhibited by coughing and choking throughout meals [2]. Dysphagia may lead to pneumonia, secondary to aspirated food and drink. Aspiration pneumonia is a common cause of death in disorders associated with FTLD [3–5]. Mealtime disturbances, a term used here to describe both behavioral and physical feeding impairments, are reported in all clinical syndromes associated with FTLD.

FTLD syndromes include behavioral-variant frontotemporal dementia (bvFTD), a disorder of behavior and cognition, and two language variants, primary progressive aphasia (PPA) and semantic dementia (SD). FTLD can also be associated with motor disturbance as observed in FTD with motor neuron disease (FTD-MND), corticobasal syndrome (CBS), and progressive supranuclear palsy (PSP) [6]. The heterogeneity of FTLD neuropathology results in each syndrome displaying a diverse and distinct profile of eating-related symptoms (Fig. 1). Disturbances during mealtimes can be characterized by physical difficulties eating, common in movement disorders, or by behavioral changes typically seen in the cognitive-behavioral presentations of FTLD.

An improved understanding of the pathology and symptomatology that contribute to mealtime disturbances following FTLD may lead to enhanced diagnostic accuracy, improved disease management, and a better understanding of the underlying neural mechanisms involved in the feeding process [7]. Few studies have evaluated eating behavior or dysphagia in individuals with FTLD neuropathology. Here we review and summarize the literature on eating behavior and swallowing impairments (dysphagia) in each of the syndromes caused by FTLD.

Methods

The databases PubMed, MEDLINE, and Embase were searched for the following keywords: “eating behavior” “dysphagia” “altered diet preference” “hyperphagia” “hyperoral” AND “frontotemporal dementia” “frontotemporal lobar degeneration” “behavioral variant frontotemporal dementia” “primary progressive aphasia” “semantic dementia” “progressive non-fluent aphasia” “corticobasal syndrome” “progressive supranuclear palsy.” Books, gray literature, and reference lists of articles were also searched. All study types were included in the narrative review. Search terms were not required to be an outcome measure of the study. Articles were not excluded or evaluated for evidence quality due to the limited research from which to draw conclusions.

Frontotemporal Lobar Degeneration

Mealtime disturbances in FTLD are characterized by aberrant eating behaviors. Aberrant eating behaviors include continued eating despite reported satiety, eating rapidly, rigid eating behavior (e.g., only eating certain textures or at specific times), changes in diet preferences, food-seeking behavior, or obsessiveness regarding the next opportunity to eat [7–11].

FTLD-related feeding behaviors affect both the individual with FTD and the caregiver. The onset of disinhibition and impulsivity in FTD contribute to mealtime disturbances and lead to increased caregiver burden [9, 12–14]. Mealtimes become a time of safety risks

Protein	FUS		TDP		Tau	
Pathology	FTLD-FUS		FTLD-TDP-43		FTLD-Tau	
Clinical presentation	FTD with motor neuron disease	Behavioral-variant FTD	Semantic dementia	Progressive nonfluent aphasia	Corticobasal syndrome	Progressive supranuclear palsy
Primary symptom	Behavior + motor	Behavior	Fluent aphasia + behavior	Nonfluent aphasia	Extrapyramidal	
Mealtime disturbance	Eating changes similar to bvFTD Dysphagia	Marked hyperphagia Dietary changes	Food faddism Mealtime rigidity Dietary changes	Minimal changes in eating habits or swallow function	Oral dysphagia	Oropharyngeal dysphagia Rapid eating

Fig. 1. Prominent mealtime difficulties in the clinical syndromes of FTLD. FTLD, frontotemporal lobar degeneration; FTD, frontotemporal dementia; bvFTD, behavioral-variant FTD.

requiring active supervision and monitoring by the caregiver [15–17]. The restriction of food by the caregiver can lead to tension between carer and individual, including aggression [17]. Health risks associated with aberrant eating behaviors include an increased BMI and the risk of aspiration [4, 10, 17, 18]. Risky behaviors, such as rapidly eating large quantities of food, can induce aspiration and asphyxiation, even when swallow function is intact [4, 19, 20]. The nature and severity of symptoms leading to mealtime disturbances do not occur in the variants equally [12, 13, 21, 22].

Behavioral-Variant Frontotemporal Dementia

bvFTD is characterized by apathy, disinhibition, stereotypic/ritualistic behavior, loss of empathy, and altered eating behaviors [22–26]. Changes in diet and eating habits occur with a higher frequency and severity in bvFTD than in any other form of dementia [6, 8]. An estimated 60% of individuals with bvFTD present with altered eating behavior at the time of initial assessment. The rate increases to 80% over the progression of the disease [27]. Aberrant eating behavior is one of six key clinical features recognized under the consensus criteria for a diagnosis of bvFTD [6, 23–26]. Aberrant eating behavior is further specified in the diagnostic criteria as the symptoms of hyperphagia, dietary changes, and/or mouthing of inedible objects [6, 23].

Hyperphagia

Hyperphagia refers to the persistent and excessive desire to consume food [28–30] and is a component of several neurological syndromes and psychiatric conditions, such as Prader-Willi and Kluver-Bucy syndrome, bulimia nervosa, and dementia [17, 29–31]. The compulsion to eat manifests as tachyphagia (eating rapidly) when food is present, or as aberrant food-

seeking when food is not immediately available [28]. Food-seeking behaviors in bvFTD include stealing food from others, demanding food repetitively at inappropriate times, or leaving the immediate environment to seek out food [14, 28]. No significant difference in the prevalence of hyperphagia has been found between individuals with bvFTD characterized by disinhibition, and individuals with behaviors characterized by apathy, despite the disinhibited appearance of food-seeking and stealing [21].

There is no clear evidence that the sensation of hunger is a prompt for hyperphagic behaviors [7]. Appetite-regulating peptide levels in subjects with bvFTD are found to be consistent with an expected satiated state between meals [18, 32, 33]. Appetite-regulating peptide levels differ between subjects with bvFTD and healthy controls. Individuals with bvFTD have lower levels of ghrelin and cortisol and higher levels of insulin and agouti-related peptide than healthy controls. The changes in appetite-regulating peptide levels correspond to an increased BMI but not the onset of hyperphagia [32, 33]. The relationship between appetite-regulating hormone level changes and FTLD neuropathology, and how these changes contribute to hyperphagia in bvFTD, is uncertain. One study suggested that peptide levels change to compensate for hyperphagia which occurs secondary to neural atrophy [32]. Alternatively, it has been suggested that changes in appetite-regulating peptide levels are a direct consequence of neural atrophy and contribute to the multifactorial nature of hyperphagia [18].

Atrophy of the right ventral insular cortex, striatum, rostral orbitofrontal cortex [34], and posterior hypothalamus [18, 35] has been associated with the onset and progression of hyperphagia. The hypothalamus is thought to be a key area involved in feeding behavior [7, 18, 36, 37]. Atrophy of the hypothalamus, typically occurring within 2 years of a bvFTD diagnosis, is found to be specific to bvFTD and does not occur in PPA [18]. As hyperphagia occurs in all variants of FTLD, though most prominently and severely in bvFTD [8, 37], it is thought that hyperphagia is the result of multisystem disruption [18].

Hyperphagia can occur early during disease progression of bvFTD, making it a possible diagnostic indicator [8, 38]. The high prevalence rate and severity of this feature may be valuable in distinguishing bvFTD from other FTLD subtypes and Alzheimer's dementia (AD) [7]. A recent study identified marked hyperphagia, as determined by total caloric intake, as being exclusive to the group with bvFTD [7]. The clinical attributes which may indicate the onset and progression rate of hyperphagia in bvFTD are undetermined [17, 37, 38]. The group at the greatest risk of displaying hyperphagic symptoms within a generalized dementia cohort are individuals with a younger age at disease onset and increased cognitive impairment [39].

Dietary Changes

Dietary changes co-occur with hyperphagia, as individuals with bvFTD have a tendency to repeatedly request or impulsively eat specific food types and flavors [31]. There does not appear to be a clear link between presymptomatic taste preferences and symptomatic preferences, as anecdotal reports describe individuals eating and requesting flavors previously disliked [40]. Changes in dietary preference are reported for all variants of FTLD [8, 10, 11, 34, 41] and occur in other forms of dementia [11]. An increased preference for sweet-tasting foods and other carbohydrates is the most common dietary change and one of the earliest mealtime variances occurring in bvFTD [8, 10, 34, 41].

A specific preference for sweet-tasting foods, a “sweet tooth,” can develop independently of, in addition to, and at a differing level of severity to a broader preference for carbohydrates [10, 41, 42]. The underlying biological mechanisms associated with the two preferences are thought to vary. A preference for sweet foods correlates with bilateral volume loss in the orbitofrontal cortices and unilateral, typically right, insula-striate area [7, 34]. The preference for carbohydrates is associated with depleted levels of serotonin. The observation that carbo-

hydrate cravings are reduced following the administration of selective serotonin reuptake inhibitors suggests that lowered serotonin levels may be a factor contributing to dietary changes in FTLD [42]. Serotonin levels are also found to be lower in individuals with AD and vascular dementia who have similar changes in dietary preferences [31].

Mouthing of Inedible Items

Mouthing of inedible objects is predominantly discussed as a component of hyperorality [6, 23–25]; however, the rate of occurrence and severity of this symptom in bvFTD remain unclear [8, 21, 23]. The discrepancy in reported frequency may stem from inconsistent use of the term “hyperorality.” Hyperorality in the bvFTD literature may refer to inappropriate oral exploration of objects [21], as the term is used in this review, or may be used in a more general context to describe any excessive oral behavior, such as hyperphagia, increased smoking, or substance abuse [8, 27, 41].

Systematic studies assessing mouthing of inedible objects in bvFTD are scarce. Early citations regarding the occurrence of oral exploration in bvFTD reference single-subject case reports [6, 23, 43]. The limited studies that systematically examine hyperorality in bvFTD find the symptom to be relatively rare and predominately occur in the final stages of disease progression [8, 21]. Mouthing of inedible objects is most likely when disinhibition is the primary behavioral symptom but not when apathy is the primary symptom of bvFTD [21]. The difference may provide insight into the region of atrophy. Disinhibition in bvFTD is associated with atrophy of the temporal poles, whereas apathy is associated with frontal lobe atrophy [21, 44], which suggests that mouthing of inedible objects may be related to temporal lobe atrophy.

Primary Progressive Aphasia

PPA is divided into three variants: SD, progressive nonfluent aphasia (PNFA), and logopenic-variant PPA [24, 26, 45–48]. All variants of PPA may be associated with AD, FTLD-tau, and FTLD-TDP pathology [47, 48]. Only SD and PNFA are subsumed under FTLD. Logopenic-variant PPA is associated with a comparatively higher rate of AD pathology and is therefore recognized as a language-onset variant of AD [47, 49]. Behavior and motor impairments are not prominent or early features of PPA, and perhaps for this reason the literature regarding feeding and swallowing difficulties in PPA remains limited. The available evidence demonstrates that aberrant eating behavior and dysphagia are present in individuals with PPA. Its onset typically occurs in the late stages of the disease [4, 8, 21, 50–54].

Semantic Dementia

SD is associated with the progressive loss of concepts and meanings [6, 21, 55]. The loss of conceptual knowledge characteristic of SD contributes to behavioral changes and serves as a feature distinguishing between feeding impairments in SD and the other clinical syndromes of FTLD.

Aberrant eating behavior in SD resembles a milder form of the bvFTD feeding symptomatology [4, 8, 10], but differences have been identified and have potential diagnostic importance [8]. These differences include a greater preference for sweets as with bvFTD or AD [8, 10, 18], food faddism (i.e., will only consume certain flavors, textures, or colors) [8], and rigid, ritualistic mealtime behaviors (i.e., will only eat at certain times or locations) [12, 21, 56]. Neural correlates of food faddism and rigid eating behavior have not been addressed in brain imaging studies. It is speculated that the behaviors are secondary to the progressing impairment of semantic knowledge [21, 57, 58], i.e., limited semantic knowledge inhibits the recognition of alternative options. For example, in the presence of intact stimulus discrimination and after controlling for the degree of language impairment, SD subjects were found

to have marked difficulty in correctly associating sensory stimuli, such as smell and taste, with the corresponding food items [57–59]. Hyperorality is found to occur most frequently in SD as compared to other syndromes associated with FTLD or AD [8]. The inability to integrate information secondary to poor multimodal semantic knowledge may contribute to hyperorality. This is attributed to an associative agnosia regarding the edibility of items and an understanding of the conditions in which items can be eaten (i.e., foods eaten raw vs. cooked, peeled, etc.) [4, 8, 52, 58].

Aberrant eating behavior in SD is found to positively correlate with declining cognitive-behavioral function [57] and displays a predictable pattern of symptom onset [8, 60]. Findings suggest that changes in food preferences (e.g., increased sugar intake, requesting specific food items, etc.) occur very early in disease progression, followed by a concurrent increase in appetite and altered eating habits (i.e., rigid or ritualistic behaviors) [8], with oral exploration of inedible objects and dysphagia, if present at all, occurring in the final stages [4, 8, 21, 52].

Progressive Nonfluent Aphasia

PNFA is the least common of the FTLD variants [45]. Symptoms include apraxia of speech and agrammatism, with behavioral and cognitive function remaining relatively unimpaired [45]. Changes in eating behavior occur less severely and with a later onset than in SD or bvFTD [6, 53].

Monitoring of eating habits and dysphagia remains important in PNFA, given the potential phenotypic overlap with PSP and CBS [61–63]. Previous work has shown that the FTLD motor phenotypes can present with symptoms that meet the criteria for a diagnosis of PNFA [64, 65]. A study from 2006 found that 70% of individuals diagnosed with PNFA had either CBS or PSP pathology when examined at autopsy [66]. Clinical screening for swallow impairments and aberrant eating behaviors, combined with an instrumental swallow assessment as indicated, shows good potential as a method for improving the diagnostic distinction between PNFA and motor disorders [4, 67]. A better understanding of changes in eating behavior and swallow function following FTLD is first needed to establish a platform on which diagnostic screening tools can be developed.

Swallow Function in FTD

Dysphagia, concomitant with motor speech deficits, is one of the initial signs of bulbar onset in FTLD [4, 68]. Pulmonary aspiration is a common and serious consequence of dysphagia. If sensation is intact, aspiration immediately induces reflexive coughing and tachypnea, which can be distressing for the individual and caregivers. The individual is at a high risk of developing a fatal aspiration pneumonia if aspiration is recurrent, sensation is poor, or the immune system is weakened [4].

Dysphagia in FTD is often first observed and chiefly characterized by delayed swallow initiation during mealtime assessments [52]. The swallow is further characterized by premature spillage of the bolus into the pharynx during mastication and reduced movement of the bolus through the pharynx when instrumental investigation is utilized [4]. Mild dysphagia has been found to occur in 57% of FTLD participants, with minimal variance across group subtypes as assessed by fiberoptic endoscopic examination of swallowing [4]. Moderate-to-severe dysphagia typically occurs only in the final stages of FTLD and is clinically observed as delayed swallow initiation [4, 8].

The occurrence and severity of dysphagia in the presentation of FTLD is thought to be one of the most accurate predictors of shorter survival, especially when the onset occurs prior to behavioral symptoms [13, 51]. Dysphagia which presents early in disease progression is attributed to a rapidly progressing neuropathology and is commonly a prodrome of FTD-MND [4, 51].

Motor Disorders with FTLD Neuropathology

FTD-MND, CBS, and PSP are common motor syndromes associated with FTLD-type presentations. Mealtime disturbances in these disorders are secondary to physical deficits such as oropharyngeal weakness, oral apraxia, reduced sensation, decreased breath support, and/or poor feeding posture [5, 19, 20].

Dysphagia is the most common reason for admission to palliative care units for individuals with PSP and CBS. It is also associated with poor treatment outcomes during palliative care and is linked to a higher risk of dying from respiration-related causes compared to individuals with Parkinson's disease [5, 69]. Alterations in eating behavior, except in FTD-MND, do not frequently occur until the late stages of disease progression [19, 20, 68].

Frontotemporal Dementia with Motor Neuron Disease

MND occurs in 10–15% of individuals initially diagnosed with bvFTD [25, 70], with a further 25–30% of individuals displaying motor symptoms insufficient to reach MND criteria [70]. FTD-MND is more insidious than either MND or bvFTD individually and has the shortest survival expectancy of any of the FTLD phenotypes [54]. Individuals with FTD-MND are at an increased risk of displaying feeding behaviors characteristic of bvFTD in combination with a deteriorating swallow function [4, 54]. Oropharyngeal weakness, progressive hyperphagia, and expiratory muscle weakness puts the FTD-MND population at a high risk of aspirating food and drink [51]. Respiratory failure secondary to aspiration pneumonia is a leading cause of death in FTD-MND [22].

Corticobasal Syndrome

Mealtime difficulties in CBS present late [71] and are characterized by impairment of the voluntary phase of swallowing [72]. The onset of progressive apraxia of speech is found to be the best indicator of possible dysphagia in CBS [19]. Progressive apraxia of speech presents as uncoordinated oral motor movements and is a prominent symptom in CBS [20, 72–75]. Individuals with CBS often present with reduced bolus control and require multiple swallows to clear the oral cavity, referred to as piecemeal deglutition [19, 72]. Individuals with CBS are thought to lack awareness of their dysphagia, as self-report has shown poor validity when further assessed by videofluoroscopic swallowing study (VFSS) [19].

Dementia with frontal-lobe-type behavioral changes can occur in CBS, but to date, changes in eating behavior have not been reported with any frequency in this population [71, 76, 77]. Cognitive functioning is not found to correlate with swallow impairment, either by self-report or VFSS [19].

Progressive Supranuclear Palsy

PSP is characterized by both oral and pharyngeal swallowing deficits occurring early in disease onset [78–80]. Dysphagia, often secondary to bradykinesia, is characterized by oral weakness, delayed swallow initiation, and reduced laryngeal elevation [20, 79, 81]. Levodopa, commonly prescribed to treat dysphagia in individuals with Parkinson's disease, is ineffective in treating the bradykinesia-related swallow impairments of PSP [79, 81, 82]. Postural modification in combination with modified diet texture presents the best current treatment option for managing dysphagia [79, 83].

Individuals with PSP are thought to present an accurate awareness of their difficulty eating and drinking when assessed by questionnaire and verified by VFSS [78, 79]. The degree of cognitive impairment positively correlates to both individual reports of difficulty and clinician-observed swallow impairment [20, 83]. Aberrant eating behaviors – namely, impulsive eating – are reported in PSP [79, 81, 84].

Table 1. Pharmaceutical treatment

Study [Ref.], year	Study type	Demographics	Drug class	Drug name	Results
Pompanin et al. [93], 2014	Case report	64-YO female bvFTD MMSE 24/30	SSRI Antiepileptic	Fluvoxamine (100 mg/day) with topiramate (50 mg/day)	Improvement in binge-eating as evidenced by 5-kg weight loss in a month
Shinagawa et al. [94], 2013	Case reports	<i>Case 1:</i> 78-YO female bvFTD; MMSE 16/30 <i>Case 2:</i> 47-YO male SD; MMSE 10/30 <i>Case 3:</i> 57-YO male FTLD (no lobar atrophy) MMSE 20/30	Antiepileptic	Topiramate (<i>Cases 1 + 2:</i> 100 mg/day; <i>Case 3:</i> 150 mg/day)	<i>Cases 1 + 2:</i> improvement only in compulsive eating behaviors as evidenced by APEHQ score <i>Case 3:</i> no significant changes in eating behavior
Singam et al. [95], 2013	Case report	41-YO male bvFTD	Antiepileptic	Topiramate	Improvements in hyperphagia and seeking out of sweets after 3 weeks
Nestor [96], 2012	Case report	56-YO male FTLD with rostral temporal lobe atrophy	SSRI Antiepileptic Antipsychotic	Fluvoxamine (150 mg/day) Topiramate (25 mg/day) Olanzapine (5 mg/day)	Weight loss, normal eating rate, and reduction in sweet food and alcohol intake reported by spouse
Cruz et al. [97], 2008	Case report	53-YO male FTD; MMSE 16/30	Antiepileptic	Topiramate (initiated 100 mg/day, further increased to 100 mg/b.i.d.)	Improvement in alcohol abuse, per spouse report; no improvement in compulsive eating of sweet and carbohydrate food groups
Lebert et al. [98], 2004	Randomized placebo- controlled trial	16 females, 15 males Mean age 61.7 years FTD MMSE 20.8±8.3	Antidepressant (atypical serotonergic agent)	Trazodone	Participants with more severe aberrant behaviors, per NPI, demonstrated the greatest response to treatment
Moretti et al. [99], 2003	Randomized, controlled, open-label trial	<i>Group A:</i> 3 males, 5 females Age 64.56±4.46 years FTD (bvFTD and SD) MMSE 24.125±1.88 <i>Group B:</i> 3 males, 5 females Age 64.56±3.21 years FTD (bvFTD and SD) MMSE 22.875±2.99	Group A: SSRI Group B: nootropic	Paroxetine (20 mg/day) Piracetam (1,200 mg/day)	Group A showed statistically significant improvements in behavioral symptoms; an improvement in eating behavior could be demonstrated with long-term use
Swartz et al. [42], 1997	Prospective clinical trial	7 males, 4 females Mean age 60.4 years FTD MMSE 22.9±5.1	SSRI	Fluoxetine (20 mg/day) (<i>n</i> = 5) Sertraline (range 50–125/ day) (<i>n</i> = 5) Paroxetine (20 mg/day) (<i>n</i> = 1)	Carbohydrate cravings improved in 56% of participants

APEHQ, Appetite and Eating Habits Questionnaire; bvFTD, behavioral-variant frontotemporal dementia; FTD, frontotemporal dementia; FTLD, frontotemporal lobar degeneration; MMSE, Mini-Mental State Examination; NPI, Neuropsychiatric Inventory; SD, semantic dementia; SSRI, selective serotonin reuptake inhibitor; YO, year-old.

Treatment

Current treatments for aberrant eating behavior in FTLD are intended to ameliorate symptoms rather than modify the disease [85]. Mealtime disturbances are primarily managed by increased caregiver supervision. Recommended management techniques include locking food away, reducing access to large portions, monitoring for food-seeking or stealing, providing healthy alternatives to sweets, cueing the individual to slow down during meals, modifying diet texture as needed, and ensuring proper body positioning for safe swallowing (e.g., bolt upright) [16, 79, 85, 86]. Rehabilitation clinicians can assist caregivers in modifying the eating environment, providing appropriate cues during meals, managing dietary changes, and reducing aspiration risks [87]. Speech pathologists can provide alternative communication methods for individuals unable to verbalize wants and needs during mealtime. To

date, there have been no clinical trials on managing mealtime difficulties following FTLD [88]. Studies of behavioral and environmental interventions in FTD, including behaviors not related to mealtime, are restricted to case reports [16].

The literature regarding pharmaceutical interventions for aberrant eating behaviors (described in Table 1) is primarily limited to case reports. Topiramate, an antiepileptic drug with a side effect of appetite suppression, has been reported to reduce hyperphagia. The antidepressant class of selective serotonin reuptake inhibitors have some benefit for altered dietary preferences [85]. Pharmaceutical management also includes identifying prescribed medications which may be exacerbating eating behavioral symptoms [89].

Limitations of the Literature

Caregiver Report

A description of assessment measures was not included in this review, as it has recently been discussed [37, 90, 91]. Caregiver report has been the predominant method used to assess dietary changes and eating behaviors throughout the literature. Caregiver questionnaires are limited by subjectivity and are susceptible to the caregiver's quality of life. Caregivers with a higher sense of perceived burden, affected by secondary factors such as poor environmental support, are more likely to rate the individual they care for as having an increased severity and frequency of symptoms [92]. Caregivers of individuals with FTD report a higher rate of stress than caregivers of other types of dementia. Biases associated with caregiver burden need to be considered when examining the presence and severity of mealtime disturbances in FTD by caregiver rating or description of symptoms. A study comparing caregivers' report of symptoms of hyperphagia to clinician observation illustrates this effect. The study found that caregivers trended towards overrating the presence and severity of symptoms. Thirty percent of the subjects identified as having hyperphagia based on caregiver report of symptoms did not meet the criterion for classification when the term "hyperphagia" was standardized to mean consumption which is greater than 2 standard deviations from the norm [17].

Limited Studies and Population Sizes

Research regarding mealtime difficulties following FTLD is limited by the number of studies that systematically examine eating behavior or dysphagia exclusively. Much of the evidence on mealtime difficulties in FTD is derived from the Cambridge Behavioral Inventory (CBI). The CBI is designed to discriminate between FTD and AD [12]. Studies using the CBI report differences in eating behavior between FTD and AD; however, change in eating behavior is one of many cognitive-behavioral symptoms described. The aim of these studies is typically to capture a broad spectrum of behaviors, and therefore they do not provide an in-depth description of the eating behaviors or their progression [35]. There is a paucity of research which evaluates swallowing impairment following FTLD, as only a few studies use instrumental investigation to fully describe the impairments [4, 8, 19, 20, 52, 79].

The quality of the included studies was not formally assessed for this review. Many of the randomized controlled trials which evaluate changes in eating behavior and swallow function following FTLD are based on relatively small cohorts. Other studies describe anecdotal evidence or are case reports.

Conclusions and Future Direction

Cognitive and motor impairments can have devastating effects on activities of daily living. Mealtime is especially susceptible to these deficits. Aberrant eating behavior and swallowing difficulties can drastically reduce an individual's independence and greatly increase caregiver stress. Current standardized assessments designed to evaluate mealtime disturbances in the FTLD population are limited as they draw on third-party reporting or are limited in number and population size. The identification of features, such as mealtime disturbances, which hasten a diagnosis is a key area of exploration within the field neurodegeneration research. It is not until mealtime disturbances have been adequately characterized that researchers can begin to develop interventions to extend feeding independence and improve the quality of life of individuals with syndromes resulting from FTLD.

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Author Contributions

C.L.: acquisition of data, analysis or interpretation of data, and drafting of the manuscript. M.W.: analysis or interpretation of data and critical revision of the manuscript for intellectual content. D.V.: analysis or interpretation of data and critical revision of the manuscript for intellectual content. A.P.V.: study concept and design, interpretation of findings, revision of the manuscript, and study supervision.

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