Voluntary Swallowing Initiation Difficulty After Dorsomedial Prefrontal Cortex Damage: A Case Report

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Abstract: The dorsomedial prefrontal cortex plays a critical role in movement initiation, and damage to this area can impair this function. Here we present the case of an individual who had difficulty with voluntary initiation of liquid swallowing after surgical removal of a glioblastoma from the right dorsomedial prefrontal cortex. This individual had no difficulty swallowing solids, perhaps because of the additional external movement triggers (eg, chewing) involved. Liquid swallowing involves fewer movement triggers and requires a quicker application of force during the oral propulsive phase when liquids are transferred from the oral cavity to the oropharynx. This individual did not have buccofacial apraxia or apraxia of speech, which are often associated with swallowing apraxia linked to damage in the precentral, premotor, and inferior frontal gyri. To our knowledge, few studies have focused on movement initiation impairments affecting the upper extremities and speech, and cases involving swallowing are notably rare.

Key Words: initiation difficulty, swallowing, liquid, solid, dorsomedial prefrontal cortex

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GLOSSARY

dACC = dorsal anterior cingulate cortex. **dmPFC** = dorsomedial prefrontal cortex. **SMA** = supplementary motor area.

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The patient provided informed consent to participate in this study.

The data sets generated and/or analyzed during the current study are not publicly available, but are available from the corresponding author (M.F.) upon reasonable request.

N.M., A.N., T.N., and M.B. collected data. M.F. and S.K. conceived the original idea and drafted the initial version of the manuscript. S.K. proposed mechanisms for swallowing difficulties. All authors have reviewed and approved the submitted version of the manuscript.

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Recent research has highlighted the significance of the dorsomedial prefrontal cortex (dmPFC) in movement initiation (Brugger et al, 2020; Srinivasan et al, 2013). Bilateral damage to the dmPFC can result in akinetic mutism, characterized by reduced voluntary movements and profound apathy with preserved consciousness and sensorimotor abilities (Mega and Cohenour, 1997; Sibille et al, 2016). Akinetic mutism broadly impairs movement with no restriction to a specific form or phase of action. However, literature on selective motor initiation deficits as a result of dmPFC injury is scarce. Speech initiation difficulties in two individuals with right dmPFC lesions have been documented (Chang et al, 2007), as well as 2 cases of movement initiation difficulty in the unilateral upper extremity following hemorrhage or infarction in the unilateral dmPFC (Fukui et al, 1987; Otsuki et al, 1996). To our knowledge, selective impairments in swallowing following dmPFC damage have not been previously reported.

Swallowing is a complex process involving a coordinated sequence of reflexive and voluntary actions, regulated by specialized neural networks and effectors (Jean, 2001; Lagermann et al, 2018; Malone and R, 2024). Reflexive swallowing is primarily controlled by the dorsal and ventral swallowing groups (Jean, 2001; Lagermann et al, 2018). The dorsal swallowing group is comprised of the central pattern generator in the medulla oblongata, anchored by the nucleus tractus solitarius. The ventral swallowing group is located near the nucleus ambiguus. Neurons in the dorsal swallowing group are responsible for initiating, shaping, timing, and sequencing the swallowing process, while those in the ventral swallowing group distribute the swallowing drive to associated motoneurons (Jean, 2001; Lagermann et al, 2018).

The central pattern generator integrates afferent signals from peripheral sensory sources—such as oropharyngeal, laryngeal, and esophageal receptors—and supramedullary inputs (Jean, 2001; Lagermann et al, 2018). While both sources elicit swallowing, voluntary swallowing is primarily governed by supramedullary input, particularly from the dorsal anterior cingulate cortex (dACC), the supplementary motor area (SMA), the insula, and the inferior frontal gyrus. Each area is crucial in initiating and modulating swallowing (Lagermann et al., 2018; Satow et al, 2004; Watanabe et al, 2004; Yamamura et al, 2018). Voluntary swallowing is linked to the phases preceding reflexive swallowing (Jean, 2001; Lagermann et al, 2018; Malone and R, 2024).

Voluntary swallowing impairment has been reported in both swallowing apraxia and Foix-Chavany-Marie syndrome (Lang et al, 1989; Uttner et al, 2012). Swallowing apraxia involves difficulty coordinating lingual, labial, and mandibular movements without muscle weakness, abnormal tone, sensory deficits, cognitive decline, or comprehension difficulties. It typically manifests before the oral propulsive phase of swallowing and has been associated with damage in the precentral gyrus and its underlying white matter (Alfaris et al, 2022; Kawnayn et al, 2023; Yun et al, 2019). Foix-Chavany-Marie syndrome, also known as bilateral anterior opercular syndrome, is characterized by impaired voluntary control over face, tongue, and mouth movements, but intact cough and swallowing reflexes. This syndrome often involves buccofacial apraxia, apraxia of speech, and limb apraxia (Lang et al, 1989; Uttner et al, 2012) and is linked to damage in the bilateral or unilateral inferior frontal cortex, specifically the opercular part (Cascio Rizzo et al, 2022; Konieczny et al, 2008; Nowak et al, 2010).

While analyses of these conditions have helped identify the roles of the precentral gyrus, the premotor gyrus, and the inferior frontal cortex in voluntary swallowing, research on the involvement of the dmPFC remains rare, particularly regarding the dACC and SMA (Brugger et al, 2020; Srinivasan et al, 2013). These areas are known to contribute to movement initiation and the control of voluntary swallowing before the swallowing reflex occurs (Satow et al, 2004; Watanabe et al, 2004).

Here, we report the case of an individual with swallowing initiation difficulty following dmPFC damage and highlight the specific contributions of this region to movement initiation, with a particular focus on swallowing.

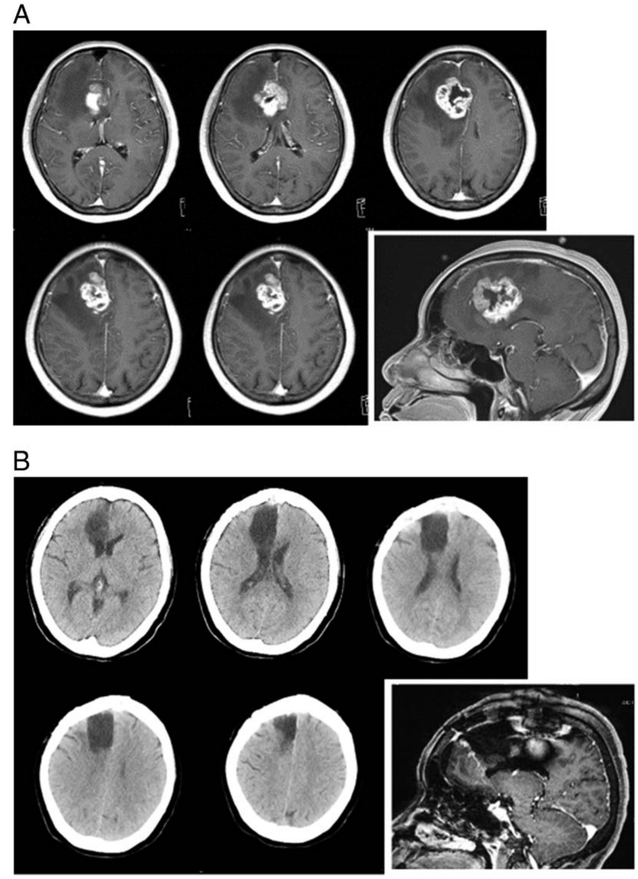

FIGURE 1. Brain imaging before and after surgery. **A.** Before surgery: axial and sagittal views of the brain in contrast-enhanced T1-weighted MRI. **B.** Two weeks after surgery: axial view in CT and sagittal view in contrast-enhanced T1-weighted MRI. The MRI image displays an artifact primarily in the supplementary motor area that is attributable to metal-containing fixation drainage applied to the surface of the brain.

CASE REPORT

This individual, a 63-year-old right-handed female, experienced cognitive decline for several weeks before seeking medical attention at a local clinic. Her symptoms included a substantial increase in the time it took her to prepare dinner and mild left-sided weakness. A head CT revealed a mass in the right dmPFC. After further examination, she was referred to our hospital.

Upon examination by a neurosurgeon, our patient was alert with no sensory deficits. MRI revealed a cystic mass slightly smaller than 4 cm in the right dmPFC attached to the cerebral falx, with ring enhancement identified after gadolinium administration. The MRI also showed edema extending beyond the right hemisphere to the left dmPFC, causing a midline shift (Figure 1A). Cerebral angiography showed enhancement of the tumor. CT of the chest, abdomen, and pelvis detected no abnormalities or additional tumors. Routine laboratory test results were normal. After the tumor was surgically removed, we established a pathological diagnosis of grade IV glioblastoma.

Our patient rapidly regained consciousness after surgery. One day post-surgery, her score on the Glasgow Coma Scale (Teasdale and Jennett, 1974) was E4V4M6. She did not exhibit significant apathy, though she did have left hemiparesis. When evaluated using the Medical Research Council system, the patient's left lower extremity was grade 3, and her left upper extremity was grade 4. She exhibited a sucking reflex and forced grasping (grasp reflex and instinctive grasp responses) in her left hand. There were no signs of aphasia or limb apraxia. Her speech was fluent, free from distortions, prosodic deficits, sound substitutions, articulatory groping, and syllable segmentation, and her speaking rate was normal. At the neurosurgeon's request, a speech-language pathologist (N.M.) assessed the patient's swallowing function.

During this evaluation, the patient was unable to swallow a spoonful of water, which remained in her oral cavity. However, her palate exhibited the proper movements and sensations, and her gag reflex was normal. The following day, while attempting to consume solid food, the patient reported that she was able to ingest solids but was unable to drink liquids despite a desire to do so. Examination by the speech-language pathologist confirmed that the patient could swallow solids. However, liquids would remain in the patient's oral cavity. The patient was unable to either swallow or expel liquids, necessitating the use of suction. This difficulty markedly interfered with the patient's ability to take essential medications, so a nasogastric feeding tube was inserted.

Four days post-surgery, our patient's score on the Glasgow Coma Scale had improved to the maximum possible (E4V5M6). Six days post-surgery, her rating on the Medical Research Council system improved to grade 5 for her left upper extremity.

Seven days post-surgery, the patient began gait training using a suspension device providing 20 kg of unloading. She was able to naturally move her left lower limb to walk at this time. Ten days post-surgery, the patient began gait training with light assistance from parallel bars before progressing to walking with a walker.

Two weeks post-surgery, the patient no longer exhibited a sucking reflex. During this time, we conducted brain imaging, which revealed a cavity in the right dmPFC, including the dACC, SMA, pre-SMA, and Brodmann Area 8 in the superior frontal gyrus where the tumor had been removed (Figure 1B). The previously observed contrast enhancement in the cingulate gyrus and corpus callosum had reduced, and the compression that had been evident on the contralateral frontal lobe was alleviated.

Three weeks post-surgery, the patient began a course of chemotherapy with temozolomide and underwent radiation therapy at a total dose of 60 Gy over 30 daily sessions.

Six weeks post-surgery, the patient no longer exhibited a forced grasping reflex in her left hand. Eight weeks post-surgery, the patient's rating on the Medical Research Council system improved to grade 4 for her left lower extremity and she had regained the ability to walk unaided. She had also regained the ability to swallow water and oral medications, so her nasogastric feeding tube was removed at this time.

Ten weeks post-surgery, the patient was discharged from the hospital and able to independently perform activities of daily living. She continued temozolomide treatment for the following 17 months. Unfortunately, tumor recurrence was observed 15 months post-surgery, extending to the lateral ventricle wall. Despite undergoing a second round of radiation therapy at the same dosage, the patient died of a brainstem hemorrhage caused by the tumor 20 months post-surgery.

ASSESSMENT

We evaluated our patient's cognitive function before her surgery. For 2 months beginning immediately after surgery, a speech-language pathologist (N.M.) conducted series of assessments focused on the progression of swallowing function, cognitive function, and orofacial praxes. A rehabilitation physician (M.B.) assisted with videofluoroscopic swallowing studies.

Swallowing Rehabilitation

The patient began daily swallowing rehabilitation 1 day post-surgery. The speech-language pathologist recorded changes in swallowing function during each session and assessed the patient's ability to swallow liquids in detail, including variables of viscosity, temperature, and taste.

Cognitive Function

We evaluated our patient's basic cognitive function using the revised version of Hasegawa's Dementia Scale (Katoh et al, 1991), an assessment similar to the Mini Mental State Examination commonly used in Japan. The scale assesses orientation, memory, repetition, backward digit span, calculation, and category fluency with a maximum score of 30. The cutoff score for impairment of cognitive function is 23/24 on the Japanese version of the Mini Mental State Examination (Sugishita et al, 2010) and 20/21 on the revised version of Hasegawa's Dementia Scale.

We used the Japanese version of Kohs Block Design Test (Owaki, 1966) to assess general intelligence because it allowed for a quick evaluation during the brief time between the patient's diagnosis and surgery. This test is an alternative to the Wechsler Adult Intelligence Scale, with an intelligence quotient (IQ) of ≥ 75 considered normal. We used the Japanese version of the Behavioural Assessment of the Dysexecutive Syndrome (Kashima, 2003) to assess executive function. On this test, a score of ≥ 70 adjusted for age is within the normal range.

Orofacial Praxes

We used the buccofacial praxes test (comprised of two subtests) from the supplementary Standard Language Test of Aphasia (Japan Society for Higher Brain Function, 2011) to assess for buccofacial praxes 29 days post-surgery. The first subtest assesses basic movements such as opening and closing the mouth, moving the tongue in the anterior-posterior direction, and reflexive elevation of the soft palate during the repeated pronunciation of "A." It also includes sensory examinations of the face, lips, tongue, and soft and hard palates.

The second subtest assesses orofacial praxes and incorporates 14 voluntary movements, including sticking out the tongue, exhaling, showing teeth, protruding the lips, licking the upper lip with the tip of the tongue, biting the lower lip with the teeth, whistling, coughing, sticking out and retracting the tongue, clicking the teeth together, clicking the tongue, furrowing the forehead, inflating the cheeks, and moving the tongue from side to side.

Swallowing Function

We used a videofluoroscopic swallow study to assess the patient's swallowing function 29 days post-surgery. This procedure involves using real-time x-ray (fluoroscopy) to precisely monitor the movements of the oral and pharyngeal structures during swallowing, allowing for detailed analysis of each phase of swallowing (Carbo et al, 2021; Logemann, 2014; Malone and R, 2024; Matsuo and Palmer, 2008; Palmer et al, 1992, 2007). These phases include:

1. The oral preparatory phase, when food is voluntarily chewed and mixed with saliva.

2. The oral propulsive phase, when the bolus is voluntarily moved to the back of the mouth (oropharynx) by the tongue.
3. The pharyngeal phase, when reflexive mechanical pressure is applied to push the food into the esophagus.
4. The esophageal phase, when the bolus is propelled through the esophagus into the stomach by reflexive esophageal peristalsis.

Our patient underwent a videofluoroscopic swallow study under two conditions: while swallowing solid food (cookies) and while swallowing a small amount of liquid (4 mL barium solution) with a tablet-like candy representing oral medication. We used a thickener containing dextrin and thickening polysaccharides to adjust the solution to three different viscosities, as described by the International Dysphagia Diet Standardisation Initiative (Cichero et al, 2017): Level 4 (extremely thick, pudding-like liquids), Level 2 (mildly thick liquids; nectars), and Level 0 (a barium solution with no thickener). We also prepared a 4 mL barium solution with no thickener or tablet-like candies to further investigate the effect of adding a medication-like tablet. Finally, we prepared a 30 mL barium solution without thickener or candies to investigate the effect of different volumes of liquid.

Because our patient had difficulty swallowing liquids, but not solids, we included two conditions for each. Swallowing mechanisms for solids and liquids differ even in healthy individuals (Palmer et al, 1992). During the oral preparatory phase, there is no chewing movement for liquid swallowing. During the oral propulsive phase, there is no intermediate phase involving the transfer of liquid from the oral cavity to the oropharynx for solid swallowing. Instead, this transfer occurs before the onset of swallowing.

In one study, a videofluoroscopic swallow study showed that the time interval between barium entering the pharynx via the oral cavity and the onset of swallowing for liquid swallowing was extremely short: ~0.1 seconds (Palmer et al, 1992). In contrast, this phase in solid swallowing typically took an average of 1.1 seconds. Liquid swallowing occurs almost instantaneously when compared to solid swallowing during the oral propulsive phase. The use of a thickener in liquid swallowing is intended to make the liquid bolus easier to manage by slowing down the transfer from the oral cavity to the oropharynx (Cichero et al, 2013).

RESULTS

Swallowing Rehabilitation

Our patient had difficulty ingesting liquids such as water or tea, including when taking oral medications, until 10 days post-surgery. She also struggled to eject liquids and medications from her oral cavity without assistance, necessitating suctioning to remove them. At 9 days post-surgery, she was unable to swallow 20 mL of tea, which remained in her oral cavity for over 30 minutes. However, the patient was able to consume solids with a normal swallowing reflex. Her difficulty lay in initiating the movement to transfer liquids or medications from the oral cavity to the oropharynx, where the swallowing reflex is triggered.

Ten days post-surgery, the patient was able to expel pooled liquids from her oral cavity, and by 15 days post-surgery, she was able to swallow small amounts of liquid, such as 2 mL of tea. However, when the liquid volume increased to 10 mL, she struggled to initiate swallowing, and the liquid remained in her oral cavity. She reported difficulty swallowing larger volumes of liquid and continued to have trouble ingesting oral medication. By 24 days post-surgery, she could consume larger volumes of liquid, though still with some difficulty. At 32, 37, and 66 days post-surgery, the patient was able to ingest a small tablet, a powder suspended in liquid, and a large tablet (temozolomide for chemotherapy), respectively.

Our patient had difficulty swallowing liquids regardless of viscosity, including yogurt, jelly-like substances, and water. She also struggled to swallow both warm and cold liquids, with no significant difference based on temperature. Similarly, different flavors (eg, apple juice and salty noodle broth) were equally difficult to swallow. When the patient's trunk angle was lowered to 20 degrees to use gravity to help facilitate the movement of liquids, they still did not flow into the pharynx, remaining in the oral cavity. We observed swallowing initiation difficulties when the patient followed the examiner's instructions and when she voluntarily tried to swallow liquids at her own pace. In both situations, she had more trouble swallowing when she was more consciously aware of the difficulty of the task and had expressed frustration with her struggles. In summary, the patient had difficulty initiating the swallowing of liquids, regardless of their characteristics, gravity assistance, or whether the action was instructed or voluntary.

The patient's overall average success rate for liquid swallowing improved over successive 10-day periods, as follows:

- Days 1–10: 27% (7/26)
- Days 11–20: 47% (11/23)
- Days 21–30: 55% (17/31)
- Days 31–49: 85% (28/33)
- Days 61–70: 97% (29/30)

We observed no difficulties with solid swallowing throughout the study period.

Cognitive Function

Before surgery, the patient scored 28 points on the revised version of Hasegawa's Dementia Scale ,which decreased to 22 points at 2 weeks post-surgery, then improved to 29 points at 2 months post-surgery. Her IQ, as measured by the Kohs Block Design Test, was 75 before surgery and 80 at 2 months post-surgery. Her age-standardized score on the Japanese version of the Behavioural Assessment of the Dysexecutive Syndrome was 73 before surgery and 88 at 2 months post-surgery. These results indicate that her cognitive function remained within normal ranges throughout the observation period.

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Orofacial Praxes

The patient did not have any orofacial motor or sensory impairments. Her orofacial praxes were also normal.

Swallowing Function

During our assessment of swallowing solids, the patient readily formed a food bolus and effectively propelled it toward the pharynx and esophagus, indicating normal processes in the oral preparatory, oral propulsive, pharyngeal, and esophageal phases. In particular, the transport of the food bolus from the oral cavity to the pharynx during the oral propulsive phase, a unique process when swallowing solids, was completely normal. Our patient did not exhibit timing discrepancies between the oral propulsive and pharyngeal phases, which would have been indicative of pseudobulbar palsy. In addition, she did not exhibit any signs of the swallowing reflex disappearing or showing pattern abnormalities during the pharyngeal and esophageal phases, which are evident in bulbar palsy.

During liquid swallowing, however, the patient retained 4 mL of a barium solution and tablet-like candies (simulating oral medication) in her mouth without initiating the liquid propulsion toward the pharynx and larynx that would lead to expulsion of the liquid. Her difficulty swallowing liquids and tablet-like candies did not vary with viscosity; she experienced the same difficulty in all three levels of viscosity assessed. Liquid remained in the patient's oral cavity even when her trunk angle was adjusted from 60 degrees to 45 degrees during each condition mentioned above.

The patient was able to swallow 4 mL of barium solution without thickener or tablet-like candies. However, when attempting to swallow 30 mL of the same solution, she could manage only about 10 mL at a time, requiring three attempts to consume the full 30 mL. Although the conditions differ, this suggests a potentially smaller swallowing capacity compared to the average volume per attempt: 33.33 mL for healthy adults and 25.0 mL for individuals with head and neck cancer during the 100 mL water swallow test (Vermaire et al, 2021).

The patient expressed frustration with swallowing liquids and/or medication, further highlighting the significant impairment evident in the initiation of the oral propulsive phase of the swallowing process.

Summary of the Assessments

The patient's difficulty with voluntary initiation of swallowing for liquids and medication persisted for more than 2 months after a surgery that involved resecting an area in the dmPFC of the right hemisphere. More specifically, she had difficulty with initiation during the oral propulsive phase, a voluntary process where the bolus is moved to the back of the mouth (oropharynx) by the tongue. In contrast, the patient's swallowing reflex, oral praxes, and cognitive function remained normal. Although she displayed primitive reflexes during the early stage after the surgery—the sucking reflex and forced grasping in her left hand—these were no longer evident after 2 weeks and 1.5 months, respectively. The patient's difficulties with swallowing initiation continued beyond the disappearance of these primitive reflexes.

DISCUSSION

To our knowledge, there have been no other reports describing difficulty with voluntary swallowing initiation due to damage in the dmPFC. This symptom is distinct from swallowing apraxia and Foix-Chavany-Marie syndrome, which involve difficulties beyond the scope of voluntary swallowing initiation. These conditions often accompany buccofacial apraxia, apraxia of speech, and limb apraxia and are associated with damage to the precentral gyrus, premotor gyrus, and inferior frontal cortex.

Preoperative imaging showed that our patient's tumor and associated edema extended beyond the right hemisphere to the left dmPFC, causing a midline shift. This made it challenging to pinpoint the causal structure, although it is likely that the impact of the damage to the dmPFC was greater on the right side than on the left. Recent research highlights the critical role of the SMA, pre-SMA, and dACC of the dmPFC in movement initiation (Brugger et al, 2020; Srinivasan et al, 2013). Other studies have shown that lesions in these specific areas have contributed to difficulties with initiating both speech and upper motor movements (Chang et al, 2007 ; Fukui et al, 1987; and Otsuki et al, 1996).

Additionally, these specific areas have been linked to swallowing initiation in neurophysiological and electrical stimulation studies (Satow et al, 2004; Watanabe et al, 2004; Yamamura et al, 2018). In the current case, lesions were observed not only in the SMA, pre-SMA, and dACC but also in other regions, including Brodmann Area 8 in the superior frontal gyrus of the right hemisphere and the dmPFC in the left hemisphere. While our findings align with previous research, we could not precisely identify the neural basis of this patient's swallowing difficulties given the extent of her lesions. In the present case, our patient had difficulty swallowing liquids, but not solids, after damage to the dmPFC. Sensory properties such as viscosity did not affect her swallowing difficulties. We hypothesized that this phenomenon may be related to the role of the dmPFC in motor control in the following scenarios: (a) when self-generated movement is required, (b) when a relatively quick application of force is necessary, and (c) when high cognitive demand is involved.

Self-generated Movement

The first factor to consider is the distinction between self-generated and externally triggered actions when swallowing. Swallowing solids involves chewing, which could be considered an externally triggered action, while swallowing liquids does not. One animal study showed that inhibitory electrical stimulation to the "chewing" area of the cerebral cortex suppressed the initiation of swallowing solids, suggesting that chewing itself can trigger swallowing (Lamkadem et al, 1999). The medial frontal cortex, particularly the SMA and pre-SMA, is more strongly associated with self-generated actions than with externally triggered actions (Cunnington et al, 2002, 2003; Lau et al, 2004; Okano and Tanji, 1987; Passingham et al, 2010). Although chewing is not typically classified as an externally triggering action, it can act as a trigger for swallowing (Lamkadem et al, 1999).

Based on these findings, it is likely that our patient—who had damage to the medial frontal cortex—had difficulty with the self-generated component of swallowing liquids rather than externally triggered swallowing of solids. Due to the lack of chewing while swallowing liquids, a quicker application of force is necessary to transfer liquids from the oral cavity to the oropharynx. Future studies including a condition for liquid swallowing with chewing, such as with a highly thickened liquid, may allow further differentiation between the potential causes of this type of swallowing difficulty. Possibilities in liquid swallowing include the quicker application of force needed during the oral propulsive phase and the absence of an externally triggering movement (ie, chewing).

Rapid Application of Force

The second factor is the kinematic aspect of swallowing. The immediate transfer of liquids from the oral cavity to the oropharynx may present greater challenges than the slower transfer of solids. Functional abnormalities in the organs involved with swallowing are thought to particularly affect liquid swallowing (Matsuo and Palmer, 2008). However, this difficulty has been attributed to the inherent challenge of managing a liquid bolus rather than specific differences between liquid and solid swallowing.

A previous physiological study suggested that the dmPFC is involved in motor control particularly when high acceleration is required (Insel and Barnes, 2015). In this study, the neurons involved in movement initiation in the dmPFC of rats were active during acceleration periods, especially when changing direction from forward to backward. This indicates that the dmPFC is particularly active when rapid force application and greater acceleration are needed (Insel and Barnes, 2015).

In the current case, the rapid application of force during the oral propulsive phase needed to swallow liquids may explain the unique symptom observed in our patient. It may also explain a previously reported case where an individual had difficulty moving their left upper extremity during transitions between movements, which would likely also require rapid acceleration (Fukui et al, 1987). Similarly, our patient's increased difficulty when swallowing larger volumes of liquids could be due to the even greater force needed during the oral propulsive phase, even if the acceleration component remains similar to smaller volumes.

High Cognitive Demand

The third differentiation between solid and liquid swallowing is the level of demand for motor control. One electrophysiology study found that the increased demand for volitional control of movements, such as selecting the appropriate response tactic, resulted in increased activity in the dmPFC (Matsuzaka et al, 2013). Although this result is primarily related to cognitive demand rather than action control, it suggests that the dmPFC must exert more effort as tasks or actions become more complex. In the current case and the one mentioned above (Fukui et al, 1987), both individuals experienced increased difficulty initiating movement when they became overly conscious of their attempted actions.

This aspect may be related to the role of the dmPFC in performance monitoring (Van Noordt and Segalowitz, 2012), which also involves the ventral medial prefrontal cortex. The dmPFC has a critical role in both action initiation and performance monitoring (Passingham et al, 2010), so these patients with dmPFC damage may have a reduced capacity to allocate resources to both functions simultaneously, leading to disruptions in action initiation.

The stress or emotional response associated with increased awareness of their difficulties may have further impaired the performance of these individuals. Stress is known to impair the function of the prefrontal cortex (Arnsten, 2009). Individuals with high anxiety often fail to recruit the frontopolar cortex during emotional action control (Bramson et al, 2023). They instead rely on the dorsolateral and medial prefrontal areas, particularly Brodmann area 24 in the anterior part of the dACC. Thus, the stress or emotional response linked to heightened awareness of their disabilities may further exacerbate difficulty with action initiation by demanding more resources for emotion-related action control from the damaged dmPFC.

After considering three factors that may explain the phenomenon of liquid-selective swallowing disturbance in our patient with a dmPFC lesion—self-generated movement, quick application of force, and high cognitive demand—we suggest that further research with larger populations is needed to validate the present findings and analyze the related mechanisms in a broader context.

CONCLUSION

We have presented a patient who encountered challenges when initiating voluntary swallowing of liquids due to damage in the dmPFC. Notwithstanding that this is a single case report, it underscores the significant role of the dmPFC in motor initiation processes and suggests potential avenues for further investigations into the roles of this structure in complex motor functions.

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