Protocol for the Use of Videofluoroscopy in Pediatric Swallowing Dysfunction

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Key Words: child development disorders • deglutition disorders

A clinical and research protocol was developed to compare the sensitivity and clinical value of videofluoroscopy with the traditional bedside clinical evaluation in the evaluation of children's swallowing dysfunction. The bedside and videofluoroscopic evaluations of 33 children were reviewed retrospectively. Our findings indicated that recommendations for feeding changed for 14 of the children as a result of the information gained from the videofluoroscopic evaluation. The results suggest that videofluoroscopy provides therapists with more objective evidence than a bedside evaluation for determining the etiology of swallowing dysfunction and directing the management or treatment of this dysfunction.

Historically, when children with dysphagia or swallowing problems were referred for occupational therapy at the University of Michigan Medical Center, C. S. Mott Children's Hospital, in Ann Arbor, Michigan, a clinical bedside evaluation was used to determine the etiology of their disorder. These children were usually referred due to one or several of the following problems: choking, coughing, vomiting, nasopharyngeal regurgitation, weight loss, failure to thrive, or suspicion of aspiration with recurrent upper respiratory infections or pneumonia. According to Logemann (1983), such clinical evaluations can define swallowing disorders arising in the oral cavity but can only infer pharyngeal dysfunction and, in fact, fail to identify aspiration approximately 40% of the time. For example, clinically observable signs such as gag and cough reflexes may not be useful for therapists predicting the safety of oral feeding. Contrary to the widely held belief that the presence of a gag reflex protects against aspiration and its absence signifies a contraindication to oral feeding, Linden and Siebens (1983) found that the absence of a gag reflex was not consistently correlated with aspiration. Furthermore, some patients have an absent or diminished reflexive cough and may therefore be silent aspirators (Helfrich-Miller, Rector, & Straka, 1986; Linden and Siebens, 1983). A comprehensive evaluation of swallowing should include, therefore, not only the oral mechanisms, but also the pharyngeal stage of the swallow, which is not possible with clinical evaluation alone (Jones, Kramer, & Donner, 1985; Logemann, 1983; Siebens & Linden, 1985).

We developed a clinical and research protocol for cooperative evaluation of oral motor and swallowing functions to assess more reliably the probability of risk, the etiology of aspiration, or both, and to guide therapeutic techniques and decisions used with neurologically impaired children. We used this protocol to compare the sensitivity and clinical value of the videofluoroscopy with the clinical bedside evaluation in the evaluation of swallowing dysfunction.

Method

Subjects

Of 75 videofluoroscopy studies conducted over a 5-year period, we retrospectively reviewed the 33 that met the criteria for inclusion in the study. To meet the criteria, all required data were available and the research protocol had been followed (i.e., separate therapists conducted bedside and videofluoroscopic examinations). The diagnoses of the children's conditions are summarized in Table 1. Two of the 5 ventilator-dependent spinal cord–injured children included in the study, both of whom had brain stem involvement, had repeat studies. One child’s condi-
Table 1
Diagnosis and Age of Children Receiving Clinical and Videofluoroscopic Evaluations (N = 33)

<table>
<thead>
<tr>
<th>Diagnosis</th>
<th>n</th>
<th>Age Range</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cerebral palsy</td>
<td>11</td>
<td>11 months-13 years</td>
</tr>
<tr>
<td>Traumatic brain injury</td>
<td>5</td>
<td>3 years 1 month-15 years 5 months</td>
</tr>
<tr>
<td>Ventilator-dependent spinal cord injuries</td>
<td>5</td>
<td>2 years 1 month-14 years</td>
</tr>
<tr>
<td>Encephalopathies</td>
<td>3</td>
<td>13 years 5 months-19 years</td>
</tr>
<tr>
<td>Progressive central nervous system disorder</td>
<td>2</td>
<td>4 years 11 months-7 years 3 months</td>
</tr>
<tr>
<td>Medulloblastoma</td>
<td>1</td>
<td>17 years</td>
</tr>
<tr>
<td>Multiple cerebrovascular accident/Nephrotic syndrome</td>
<td>1</td>
<td>4 years</td>
</tr>
<tr>
<td>Anoxia/Congestive heart disease</td>
<td>1</td>
<td>9 months</td>
</tr>
<tr>
<td>30% burn/Tracheostomy</td>
<td>1</td>
<td>11½ months</td>
</tr>
<tr>
<td>Myelomeningocele/Arnold-Chiari malformation</td>
<td>1</td>
<td>22 months</td>
</tr>
<tr>
<td>Seizure disorder/Developmental delay</td>
<td>1</td>
<td>5 years 1 month</td>
</tr>
<tr>
<td>Cri du chat syndrome</td>
<td>1</td>
<td>4 years</td>
</tr>
</tbody>
</table>

Dysphagia improved and the other’s deteriorated on the repeat study, the latter being attributed to the development of an uncontrolled seizure disorder.

Bedside Examination

The clinical bedside pediatric oral motor evaluation, developed by occupational therapists at C. S. Mott Children’s Hospital, provided a detailed account of oral motor function. It included assessments of the functional performance of sucking, biting, and chewing and an assessment of laryngeal movement during swallowing (reflexive, volitional, or both). Laryngeal movement was assessed with the four-finger technique described by Logemann (1983). The functional performance components that were examined included range of motion, strength, muscle tone, and coordination of the lips, jaw, cheeks, and tongue. The presence or absence of such reflexes as rooting, gag, and bite were noted. In addition, motor and postural control of the head, neck, and extremities were recorded. The tone of the trunk, shoulder girdle, extremities, and orofacial area was assessed, including its influence on postural stability and isolated motor control and function. Oral sensory abilities were noted, primarily as responses to temperature, taste, texture, and touch. All psychosocial components observed or obtained from a gathered history or caregiver’s report were documented. Finally, information was obtained about current home or school seating or positioning used during feeding as well as about any equipment or adaptive aids used.

Besides giving a detailed account of oral motor function, the oral motor evaluation helped determine positioning requirements and method of food presentation during the videofluoroscopy examination. It assisted in the determination of whether parents or primary therapists should be present and the degree of assistance they may provide. Without a pre-videofluoroscopic examination, the therapist may not know if the feeding behavior displayed during videofluoroscopy is typical of that child. If videofluoroscopy results are to be meaningful, the therapist should mimic the feeding patterns regularly used and those that are appropriate for the child’s developmental age. This is particularly true for children with neurogenic disorders, because body position may significantly alter results.

The occupational therapist who conducted the clinical oral motor examination also completed a data sheet as part of the research protocol, documenting the reason for suspected aspiration or confirmed aspiration based on reports from caregivers or previous medical records. The data sheet included information on aspiration suspected and aspiration confirmed, as described below.

Aspiration suspected:
1. History of pneumonia and average number of illnesses per year.
2. Chronic fevers, otherwise unexplained.
3. Wheezing.
4. Stridor.
5. Chronic respiratory compromise perceived by parent (e.g., coughing, choking).
6. Feeding difficulties perceived by parent.

Aspiration confirmed:
1. Suctioning of ingested food substances from tracheostomy.
2. Bronchoscopy to remove foreign body.
3. History of chronic vomiting and/or documented gastroesophageal reflux, including type and date of study (e.g., radionuclide study, esophagoscopy).

Pre-Videofluoroscopy Category Assignment

The therapist predicted the likelihood of aspiration based on this information and on the information from the clinical evaluation. The therapists assigned the patient to the A, B, or C pre-videofluoroscopic feeding categories, as follows:

- **Category A:** Safe for oral feeding. Minimal or no risk of aspiration.
- **Category B:** Moderate risk of aspiration. Oral feeding appropriate with limitations (e.g., positioning instructions, therapeutic techniques for food presentation, specific diet, compensatory techniques such as supraglottic swallow).

• Category C: No oral feeding due to excessive risk of aspiration. Recommend therapeutic techniques to improve oral motor mechanisms, to facilitate the swallow response (e.g., exercises or developmental facilitation to improve oral motor mechanisms for improved control of bolus in preparation for swallow and to improve voluntary stage of swallow, thermal stimulation of swallow response, or both).

The children assigned to Category A had no restriction on oral feeding. The children assigned to Category B could be fed orally but with some restrictions, precautions, or special techniques. The children receiving specific instructions other than those that might apply to any child or infant of their age group belonged to this category. For example, a physician’s order to “progress feedings as tolerated” would not be considered sufficient reason for assignment to this category, nor would commonsense recommendations applicable to any child, such as those from the American Academy of Pediatrics’ 1983 task force on foods and choking in children. The children assigned to Category C were those for whom oral feedings would not be recommended.

**Videofluoroscopic Examination**

The videofluoroscopic examination is also referred to as the modified barium swallow, three-phase swallow, or cookie swallow (Logemann, 1983). It differs from the usual barium swallow. The former examines the oral, pharyngeal, and cervical esophageal physiology; the latter primarily examines the esophagus and stomach. The purpose of the evaluation is to assess oral and pharyngeal function and to define motility problems in the oral cavity and pharynx, which may influence swallowing.

Fluoroscopies were performed with the child primarily in an upright sitting position, and standard fluoroscopic equipment (0.6-mm focal spot) with image intensification was used. The videofluoroscopic methods and documentation used were adapted from Logemann (1983, 1986). The findings were recorded on videotape and occasionally on 105-mm spot films, which could be obtained in rapid sequence, up to 12 frames per second. Videotape could be reviewed in real time or at variable speed in either direction, and each frame could be stopped to allow interpretation. Repeated viewing of the videotape in slow motion allowed for the close examination of oropharyngeal motion and transient aspiration during swallowing, which was sometimes missed on the initial viewing in real time. Because the swallows were recorded on videotape, fewer swallows needed to be performed and radiation exposure could be kept lower.

Each child was examined in the lateral projection, with anterior-posterior viewing performed when indicated. For research purposes, an occupational therapist, other than the one completing the initial clinical evaluation, performed the videofluoroscopy with the radiologist. In the lateral view, many components of oral and pharyngeal motility could be assessed, including function and timing of the tongue, palate, velum, epiglottis, and such laryngeal and pharyngeal structures as the pharyngeal constrictors and the cricopharyngeus muscle. The lateral view was optimal for the measurement of oral and pharyngeal transit times, timing of the swallow reflex, and the amount and etiology of laryngeal penetration. The anterior-posterior view was performed only with foods the child had the most difficulty with and was useful in viewing asymmetries in function.

The children were seated upright for lateral viewing. For infants and small toddlers, a car seat, wheelchair insert, or feeder seat was set on the platform attached to the fluoroscopy table, which had been brought up to the full upright position, thus providing horizontal beam fluoroscopy. Coated foam rubber pieces were added as needed to achieve the position in which the child routinely eats. These positioning devices, such as a soft C-shaped collar, kept the child’s head and neck in a neutral position. The positioning devices were added or removed to allow the use of postural variations or compensatory techniques. Larger children and adolescents were placed on a chair that was narrow enough to fit between the tower and table of the fluoroscopy machine. Positioning devices or prefabricated cushions were used as indicated. Several children were tested lying on the horizontal table, due to the unavailability of a specially designed chair or cart to accommodate contractions or paresis. Positioning against gravity, however, is not generally recommended, because it may significantly affect swallowing.

Test swallows generally included three consistencies of food substances: liquid, thickened paste, and a quarter of a cookie soaked in barium (the cookie is used to evaluate mastication). The food trials varied; the textures and amounts used were often determined on an individual basis. The foods presented were based on many factors, including the child’s age, oral motor abilities, cognition, and food preferences or allergies. In the event of severe oral motor dysfunction or developmental delay, alternative means of presenting food trials (i.e., other than with a standard cup and spoon) were indicated. Several swallows of each material were given in the amount of approximately 1/2 tsp.

Three phases of swallowing were analyzed: the oral preparatory phase, the oral phase, and the pharyngeal phase. It was sometimes necessary to evaluate
Table 2
Recommended Feeding Categories for Children Correlated With the Gag Reflex (N = 26)

<table>
<thead>
<tr>
<th>Gag Reflex</th>
<th>Recommendation Category*</th>
<th>A</th>
<th>B</th>
<th>C</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hyperreflexia</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>4</td>
</tr>
<tr>
<td>Normal</td>
<td></td>
<td>4</td>
<td>7</td>
<td>1</td>
<td>12</td>
</tr>
<tr>
<td>Hyporeflexia</td>
<td></td>
<td>0</td>
<td>5</td>
<td>2</td>
<td>7</td>
</tr>
<tr>
<td>Absent</td>
<td></td>
<td>0</td>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>Total</td>
<td></td>
<td>4</td>
<td>16</td>
<td>6</td>
<td>26</td>
</tr>
</tbody>
</table>

Note. Numbers in columns signify number of patients assigned. A = minimal or no risk of aspiration; B = moderate risk of aspiration; C = severe or excessive risk of aspiration.

* p > .1 (not significant); χ² = 9.496.

the esophageal phase as well. Problems in any phase were noted, although, typically, a detailed assessment of the thoracic esophagus was not included. Timing and motility disorders that affected bolus formation and mastication were noted. Oral transit time, which begins with lingual control to propel the bolus and ends when the bolus passes the anterior faucial arches (Logemann, 1984), was measured. Symptoms that may be evident include disturbed lingual peristalsis and residue in the sulci of the oral cavity. The pharyngeal stage of the swallow begins with the initiation of the swallow reflex response (Logemann, 1983). Pharyngeal dysfunction may include a delayed or absent swallow reflex, reduced laryngeal elevation, or cricopharyngeal hypertonicity. The percentage of aspiration, which is defined as material entering the trachea below the level of the vocal cords, was noted (Jones et al., 1985). Whether aspiration occurred before, during, or after the swallow was noted, as was the risk of aspiration occurring before, during, or after the swallow (Logemann, 1984). The etiology of aspiration and possible disorders accounting for observed symptoms were delineated.

Post-Videofluoroscopy Category Assignment
The children were assigned to the post-videofluoroscopy recommendation categories as they were to the pre-videofluoroscopy categories. These recommendation categories were assigned independently before and after videofluoroscopy by different personnel reviewing the records and the videofluoroscopic results. It should be noted that the lack of aspiration on videofluoroscopic study did not necessarily mean that the child would be assigned to Category A, nor did the presence of some aspiration under some circumstances necessarily mean that the child would be assigned to Category C. In all cases, assignments were based on a complete clinical evaluation and individualized assessment. Specific recommendations and a post-videofluoroscopy summary were provided in narrative form to clarify results, particularly if the child was designated as a moderate aspiration risk and oral feedings were to continue with limitations. The results obtained from the videofluoroscopic examination were discussed with the referring physician and disseminated to the appropriate team members for follow-up.

Results
To examine the relationship of the clinical evaluation of the gag reflex with videofluoroscopy results, we analyzed the data with chi-square for the gag reflex versus the recommended feeding category. The chi-square analysis was not significant (p > .1) (see Table 2). A statistical comparison of recommendations based on the clinical bedside evaluation (pre-videofluoroscopy) with the recommendations based on the videofluoroscopic evaluation (post-videofluoroscopy) indicated that 14 of the 33 children (42.5%) changed recommendation categories due to the radiologic examination: 5 (15.2%) moved to a more restrictive feeding category and 9 (27.3%) to a less restricted category post-videofluoroscopy (see Figure 1). Notably, 1 child with pre-videofluoroscopy orders for no oral feedings was able to feed without restriction; another child, though able to feed without restriction, was recommended for no oral feedings as a result of the videofluoroscopy.

Discussion
Because traditional medical education contains very little on dysphagia evaluation, we examined some beliefs that physicians commonly hold regarding
bedside evaluation. In particular, it is widely taught that the presence of a gag reflex protects against aspiration and its absence signifies a contraindication to oral feeding. Logemann (1983) believed this to be an inadequate criterion for decision making. Although our results were not statistically significant and our sample was small, the findings suggest that the presence or absence of a gag reflex is not in itself a valuable assessment criterion for the safety of oral feeding. We noted that 1 child with recurrent pneumonia and otitis media not due to gastroesophageal reflux had a normal gag reflex. One ventilator-dependent, quadriplegic child with an absent gag reflex was clinically thriving without episodes of aspiration pneumonia and, in fact, had a problem with weight control due to overfeeding.

Splaingard, Hutchins, Sultan, and Chaudhuri (1986) also identified a discrepancy between clinical evaluation and videofluoroscopic evaluation results. They identified a kappa value of 0.38 for bedside versus videofluoroscopic evaluation (thus indicating a low correlation) on 107 patients admitted to their rehabilitation center. This discrepancy shows that aspiration risk is complex. Many factors could protect against or predispose to aspiration in any given patient.

The limitations of our study were (a) a small sample size, (b) the study's retrospective nature, and (c) our inability to examine such follow-through factors as the discrepancy between feeding category recommendations and the actual follow-through; the value of videofluoroscopy for providing new information such as changes in feeding techniques, despite no change in feeding category; and the value of the videofluoroscopy as more objective evidence in persuading caregivers to accept recommended feeding categories.

We believe that the videofluoroscopic evaluation, as compared with a clinical oral motor evaluation alone, can lead to a more definitive delineation of the etiology of and prognosis for swallowing dysfunction, thus allowing for improved management decisions. For example, a videofluoroscopic evaluation has been useful in the determination of whether gastrostomy tube placement for nutritional management is appropriate. Although 1 child did not receive the gastrostomy despite our recommendations, another was deferred from gastrostomy surgery on the basis of the videofluoroscopic evaluation and was maintained on nasogastric tube feedings until oral feedings were sufficient for both calories and fluid. In all cases, we were able to make informed decisions regarding the need for surgery.

In several patients, the videofluoroscopy helped identify problems and techniques that were unapparent from the clinical examination. For example, a 4-year-old with cerebral palsy was noted to have a 3-sec delay in initiation of the swallow response, and this information was useful in reducing the risk of aspiration by changing the pace of feedings and modifying her diet to eliminate thin liquids. In addition to identifying swallowing disorders, videofluoroscopy may be used to evaluate the effectiveness of therapeutic techniques, including positioning and postural variations, variation in food textures and consistencies, thermal stimulation, and compensatory techniques such as the supraglottic swallow. A further example of how videofluoroscopy provided more objective evidence than a clinical examination is seen in the case of a 9-year-old with cerebral palsy who wheezed and had difficulty handling liquids. Following the bedside evaluation, a gastrostomy was recommended, but the child's parents withheld consent for this surgery until they were convinced by the videofluoroscopic evaluation. The clinical significance of follow-through (or the lack of it) with the post-videofluoroscopic recommendations was not addressed by this retrospective study and would require the long-term follow-up of patients regarding nutritional status and occurrence of aspiration-related complications.

Conclusion

In reviewing the records of 33 children with oral motor dysfunction assessed both by clinical bedside evaluations and videofluoroscopic evaluations, we found that oral intake or feeding recommendation categories based on the bedside evaluations were changed in 14 children as a result of information gained from the videofluoroscopic evaluation. Caregivers, including physicians, parents, teachers, and therapists, expressed feeling much more comfortable with follow-up care regarding oral feeding, based on the information gained from the videofluoroscopic study. This confirms our belief that videofluoroscopy is a valuable addition in the assessment of dysphagia. The videofluoroscopic evaluation allows the therapist to assist with medical decisions regarding the safety and appropriateness of oral feeding as well as to decide on appropriate therapeutic management. The results of the present study suggest the need for a prospective study that uses a larger sample size, allows for the analysis of specific subgroups, and provides follow-up data on the occurrence of aspiration-related complications at 2, 4, 6, and 12 months after the videofluoroscopic evaluation.

Acknowledgment

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References


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