ANTERIOR CERVICAL OSTEOPHYTE DYSPHAGIA: MANOFLUOROGRAPHIC AND FUNCTIONAL OUTCOMES AFTER SURGERY

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Abstract: Background. Our aim was to investigate the clinical and manofluorographic findings of patients with anterior cervical osteophyte (ACO) dysphagia before and after surgery.

Methods. Chart review including manofluorography (MFG) data of patients undergoing ACO removal was undertaken.

Results. Thirteen patients underwent transcervical ACO removal over a 10-year period. A postoperative hematoma was the only surgical complication. Overall, there was a significant postoperative decrease in Functional Outcome Swallowing Scale (FOSS). MFG data showed an elevated preoperative intrabolus pressure gradient across the osteophyte (IB-Gra), 39.78 mm Hg, and IB-Gra significantly decreased to 19 mm Hg 6 months after surgery.

Conclusion. Functional (FOSS) and objective MFG (IB-Gra) improvements occurred in patients who had ACO dysphagia and underwent surgery. These findings support high IB-Gra as a reliable objective indicator for surgical intervention for ACO dysphagia and IB-Gra as an appropriate parameter for follow-up after ACO removal. In selected patients, ACO removal by anterolateral-transcervical approach is a safe and highly effective treatment.

Keywords: Cervical osteophyte; dysphagia; functional outcome swallowing scale; manofluorography; surgery

Degenerative changes in the cervical spine are common in the elderly population and may lead to anterior cervical osteophytes (ACO).1,2 These osteophytes occur in 20% to 30% of elderly population without any symptoms.1,3 However, depending on their location and size, ACO can cause otolaryngologic symptoms such as dysphagia, globus, dyspnea, or dysphonia.2,4–6 After ruling out other causes of dysphagia, ACO can remain the only reason for pharyngeal dysphagia. Pharyngeal dysphagia attributable to ACO has been the subject of many isolated case reports in the literature.1–8

Various methods including radiography, CT, MRI, electromyography (EMG), videendoscopy, videofluoroscopy, and manometry are used to evaluate dysphagia.2,3,8 Simultaneous use of videofluoroscopy and manometry, the so-called manofluorography (MFG), provides fluoroscopic images linked in time to manometric data allowing accurate interpretations of manometric
pressure readings to fluoroscopic anatomic events. MFG has been advocated to be the most accurate method for evaluating pharyngeal swallowing disorders.

The purpose of this study was to investigate the functional and manofluorographic findings of patients with ACO and to evaluate these outcomes after surgical treatment.

MATERIALS AND METHODS

A retrospective chart review from 1998 to 2008 of patients undergoing surgery for dysphagia caused by ACO was undertaken. The study group consisted of patients who underwent ACO removal via anterolateral-transcervical approach by the senior author (J.R.S.) with a neurosurgery team at Mayo Clinic Florida. Patients who underwent concomitant cricopharyngeal myotomy or Zenker’s diverticulum surgery were not included in this study. This study was approved by the Institutional Review Board of Mayo Clinic.

Medical and surgical records were reviewed to determine the demographic data, surgical complications, and the functional and manofluorographic outcomes before and 6 months after surgery. Functional outcomes were noted and categorized according to the previously published “Functional Outcome Swallowing Scale” (FOSS; Table 1). FOSS stages were recorded by the senior author (J.R.S.) or by the reviewer (O.B.O.).

Preoperative and 6-month postoperative MFG records of each patient using the Swallowing Work Station (Kay Pentax, Lincoln Park, NJ) were reviewed. A solid state, unidirectional, manometry catheter with 4 sensors spaced 3 cm apart was used (Gaeltec Medical Measurements, Hackensack, NJ). A patient’s preoperative and postoperative fluoroscopic views with catheter sensors are given in Figure 1. Fluoroscopic examinations were used to note laryngeal elevation, bolus residue, aspiration, and coordination during swallowing, and the location of cervical vertebrae with anterior osteophytes. Six manometric parameters were noted: tongue base peak clearing pressure (Tb-PCP), hypopharyngeal peak clearing pressure (Hy-PCP), cricopharyngeal resting pressure (CP-R), cricopharyngeal (CP) nadir, cricopharyngeal midbolus pressure (CP-mid), intrabolus pressure gradient (IB-Gra) across the osteophyte as it impinged on the postcricoid plate, and cricopharyngeal peak clearing pressure (CP-PCP). Three readings of each MFG pressure parameter were taken and averaged.

**Statistical Analysis.** The sign test for 2 dependent samples was used to compare preoperative, and 6-month postoperative FOSS stages, and repeated measures analysis of variance was used to compare preoperative and 6-month postoperative manometry results.

<table>
<thead>
<tr>
<th>Stage</th>
<th>Symptoms</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>Normal physiologic function without symptom.</td>
</tr>
<tr>
<td>1</td>
<td>Normal function with daily or episodic symptoms of dysphagia.</td>
</tr>
<tr>
<td>2</td>
<td>Compensated abnormal function manifested by significant dietary modifications or prolonged meal time (without weight loss or aspiration).</td>
</tr>
<tr>
<td>3</td>
<td>Decompensated abnormal function with weight loss of 10% or less of body weight over 6 months due to dysphagia; or daily cough, gagging, or aspiration during meals.</td>
</tr>
<tr>
<td>4</td>
<td>Severely decompensated abnormal function with weight loss of more than 10% of body weight over 6 months due to dysphagia; or severe aspiration with bronchopulmonary complications, nonoral feeding for most of nutrition.</td>
</tr>
<tr>
<td>5</td>
<td>Nonoral feeding for all nutrition.</td>
</tr>
</tbody>
</table>

Figure 1. Fluoroscopic view of a patient with anterior cervical osteophyte (ACO). (A) Manometry catheter and 4 sensors (arrows), (B) ACO before surgery (arrow), (C) ACO after surgery (arrow).
RESULTS

Thirteen patients underwent transcervical ACO removal without a concomitant head and neck procedure over a 10-year period. The average age of patients was 66.9 years, with an age range from 51 to 84 years. There was a male to female predominance of 5.5:1. The age and sex data of patients are given with their FOSS stages in Table 2.

The chief complaint was dysphagia manifest by dietary modifications and/or prolonged meal time in 9 patients (FOSS stage 2). Three patients had a weight loss of 10% or less of body weight over 6 months due to dysphagia (FOSS stage 3), and 1 patient had a history of aspiration pneumonia (FOSS stage 4). None of the patients had stridor or dyspnea. One patient noticed dysphonia that was subjectively improved after surgery. The majority of patients had unremarkable medical and surgical histories for any condition that may cause swallowing problems, except 1 patient who had undergone lobectomy for lung cancer and subsequent tracheostomy because of prolonged endotracheal intubation. This patient had an insensate larynx and recurrent episodes of aspiration pneumonia before ACO removal.

Flexible fiber optic examinations of the pharynx and larynx were largely insignificant except for the ACO. No vocal fold paralysis was encountered before or after surgery. Flexible fiber optic endoscopy showed a significantly desensitized larynx in the patient who had undergone lobectomy and subsequent prolonged tracheostomy.

All patients received preoperative conservative treatment including 1 or more of the following: diet modification, swallowing therapy, anti-inflammatory drugs, and muscle relaxants.

Adequate data for preoperative and postoperative FOSS staging was available in the chart of every patient. All patients improved at least 1 FOSS stage after surgery. Overall, there was a significant decrease in FOSS stages, \( p < .001 \) (Table 2). The only patient who remained in FOSS stage 3 after surgery was the 1 who had insensate larynx and aspiration pneumonia before ACO removal.

All patients had preoperative MFG, but only 9 of 13 patients underwent postoperative MFG, and thus, results of these 9 patients were used for statistical comparison.

The fluoroscopic examinations depicted ACO in varying segments from the second to the seventh cervical vertebrae (C2–C7). C5 was most commonly involved (in 10 of 13 patients), whereas C2 was involved in only 2 patients. All patients had ACO contacting the postcricoid plate during laryngeal elevation. Anterior and superior elevation of larynx during swallowing was normal in the fluoroscopic examinations of all patients and no coordination abnormality was noted. This finding was also confirmed by the normal cricopharyngeal nadirs on manometric evaluation of these patients. Eight patients had tongue base and hypopharyngeal bolus residuals cleared by repeated swallows. Aspiration was noted in only 1 patient and persisted as silent aspiration after surgery.

**Table 2.** Age, sex, and preoperative–postoperative FOSS stages of patients.

<table>
<thead>
<tr>
<th>No.</th>
<th>Age, y</th>
<th>Sex</th>
<th>Preop. FOSS</th>
<th>Postop. FOSS</th>
<th>Change in FOSS stage</th>
<th>( p^* ) value</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>69</td>
<td>M</td>
<td>4</td>
<td>3</td>
<td>– 1</td>
<td>&lt; .001</td>
</tr>
<tr>
<td>2</td>
<td>73</td>
<td>M</td>
<td>2</td>
<td>1</td>
<td>– 1</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>65</td>
<td>M</td>
<td>3</td>
<td>1</td>
<td>– 2</td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>51</td>
<td>F</td>
<td>2</td>
<td>0</td>
<td>– 2</td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>55</td>
<td>M</td>
<td>2</td>
<td>0</td>
<td>– 2</td>
<td></td>
</tr>
<tr>
<td>6</td>
<td>57</td>
<td>F</td>
<td>2</td>
<td>1</td>
<td>– 1</td>
<td></td>
</tr>
<tr>
<td>7</td>
<td>73</td>
<td>M</td>
<td>3</td>
<td>2</td>
<td>– 1</td>
<td></td>
</tr>
<tr>
<td>8</td>
<td>70</td>
<td>M</td>
<td>2</td>
<td>1</td>
<td>– 1</td>
<td></td>
</tr>
<tr>
<td>9</td>
<td>61</td>
<td>M</td>
<td>2</td>
<td>0</td>
<td>– 2</td>
<td></td>
</tr>
<tr>
<td>10</td>
<td>78</td>
<td>M</td>
<td>2</td>
<td>1</td>
<td>– 1</td>
<td></td>
</tr>
<tr>
<td>11</td>
<td>76</td>
<td>M</td>
<td>2</td>
<td>0</td>
<td>– 2</td>
<td></td>
</tr>
<tr>
<td>12</td>
<td>58</td>
<td>M</td>
<td>2</td>
<td>1</td>
<td>– 1</td>
<td></td>
</tr>
<tr>
<td>13</td>
<td>84</td>
<td>M</td>
<td>3</td>
<td>2</td>
<td>– 1</td>
<td></td>
</tr>
</tbody>
</table>

Abbreviations: FOSS, functional outcome swallowing scale; M, male; F, female.

\( * \) The sign test for 2 dependent samples.
Manometry records revealed no significant change from before to after surgery in the mean tongue base peak clearing pressure, hypopharyngeal peak clearing pressure, cricopharyngeal resting pressure, or cricopharyngeal peak clearing pressure \((p > .001)\). All patients had elevated intrabolus pressure gradient across the osteophyte before surgery. A significant decrease in IB-Gra from 39.78 mm Hg preoperatively to 19 mm Hg 6-months postoperatively and a significant change was found, \(p < .001\) (Table 3).

The only surgical complication was a postoperative hematoma resulting in partial airway compromise requiring emergency endotracheal intubation. This complication occurred despite an appropriately located active drain. It was successfully managed by cervical exploration at the same day as the primary surgery. Arterial bleeding from the drilled bony vertebral body was found and stopped with cautery and bone wax.

**DISCUSSION**

Swallowing is a complex physiologic mechanism that transfers materials from the mouth into the stomach. Dysphagia is a symptom that is defined as an abnormality in the process of swallowing. As such, dysphagia is not a diagnosis.\(^{14}\) Swallowing is generally divided into 3 phases: the voluntary oral phase, and involuntarily pharyngeal and esophageal phases. Determination of the level or levels at which dysphagia occurs is crucial for etiological investigation and essential for determining the therapeutic approach.\(^{10}\)

Historically, the videofluoroscopic swallowing study is considered to be the gold standard for evaluating pharyngeal dysphagia.\(^{10,15–17}\) It is a noninvasive method providing real-time assessment of swallowing process that can be reviewed in slow motion. However, 2 basic limitations of videofluoroscopy have been reported: (1) controversial interrater reliability, and (2) inability to quantify the pharyngeal dynamics.\(^{11,17}\)

More recently, esophageal manometry has emerged as the gold standard to investigate esophageal motility and swallowing disorders, but its role to identify pharyngeal swallowing disorders is limited by technical problems that include sensor positioning errors (particularly...
in the absence of normal upper esophageal sphincter function); catheter movement by the contraction of the soft palate; variable laryngeal movement; and variable pharyngeal length. These errors can be solved by the simultaneous recordings of videofluoroscopy and manometry available in MFG which allows accurate positioning of sensors in relation to anatomic structures. MFG combines the advantages of the dynamic fluoroscopic visualization with simultaneous quantitative pressure recordings during the swallowing process. These pressure recordings can be extrapolated to indicate muscular strength for given sensor locations.

MFG is used by the senior author (J.R.S.) for selected patients with unusual or questionable results from a modified barium swallowing study and all patients undergoing surgery for pharyngeal swallowing disorders. Publications on MFG at our institution included proposed catheter standards, intrabolus pressure determination and normal cricopharyngeal intrabolus pressures in the young and old population. In the latter study, the mean midbolus pressures in older subjects was 10.8 ± 8.8 mm Hg and the mean gradient pressure across the 3-cm cricopharyngeal region for the same subjects was 4.38 ± 3.1 mm Hg. Regarding these findings and on the basis of a single case, it was suggested that intrabolus pressure gradient across the cricopharyngeal region may be an indicator for patients who might benefit from cricopharyngeal myotomy. For patients with other possible pharyngeal obstruction (ACO), we use the intrabolus pressure gradient across the obstruction as an indicator for possible surgery. In our ACO study group, the mean intrabolus pressure gradient across the osteophyte was 39.78 mm Hg before the surgery. When comparing these manometric results with the normal results previously reported from our institution, preoperative IB-Gra in our patients were markedly higher than normal. Moreover, we found a statistically significant postoperative decrease in IB-Gra from 39.78 to 19 mm Hg (p < .001). Even though our mean postoperative IB-Gra was still higher than the older normals above, we considered the decrease in IB-Gra after surgery as an objective finding confirming the functional improvement in the FOSS stages.

Fluoroscopic swallowing study alone can suggest ACO dysphagia. Our fluoroscopic examinations depicted ACO within the segments from the second to the seventh cervical vertebrae (C2–C7). Laryngeal elevation, coordination abnormalities, and bolus residue and/or aspiration can be identified by fluoroscopy. However, patients with ACO may also have other abnormalities that cause or contribute to swallowing difficulty. Using fluoroscopy alone, it may be difficult to determine if bolus residual is due to muscular weakness or obstruction from the ACO. Hence, in our institution, we have used MFG for these patients since 1997. MFG can help to identify muscular weakness (low pressures) or other contributing swallowing disorders in patients with ACO. This allows further or concomitant treatment for ACO patients who have more than 1 potential cause of dysphagia. Only 1 of our patients had both ACO and neuromuscular disease (insensate larynx) in this study. We recommend MFG for every patient with dysphagia and ACO to determine if the ACO is a significant factor and to rule out other possible causes of dysphagia.

ACO at C2 and C3 have been reported to be a risk factor for the development of airway compromise. They can cause stridor or dyspnea, and dysphonia. Even though some of our patients had ACO at C2 and/or C3, none of them had meaningful airway problems. There was, however, only 1 patient who reported dysphonia that was improved after surgery. Given his age of 84 years and the absence of objective preoperative data, we could not differentiate whether his dysphonia was due to presbyphonia or ACO.

All of our patients were improved at least 1 FOSS stage after surgery. The majority of our patients (10 of 13) were in stage 0 or 1 after surgery. Two patients remained in stage 2. It was noted that these 2 patients had the lowest preoperative Tb-PCP and Hy-PCP, respectively. We considered that their weak tongue base or hypopharyngeal driving forces were attributable to their stage 2 postoperative swallowing status. The remaining 1 patient who had undergone lobectomy for lung cancer had aspiration pneumonia before surgery. Even though he gained weight and noticed marked improvement in swallowing after surgery, we put him into FOSS stage 3 because of silent aspiration that was seen in his postoperative MFG.

FOSS is a clinically useful functional scale that has been routinely used at MCF for dysphagia patients seen by the senior author since 1994. However, it lacks the information pertaining to the psychosocial and emotional impact of dysphagia on patients. As it is a clinician-based...
Assessment tool, it does not include patients’ perspective and is not a comprehensive measure of quality of life.

ACO may occur in 20% to 30% of elderly population which also have significant incidence of dysphagia. Therefore, many patients with ACO are referred to our surgeon team. Even though we are not able to identify the exact number, the fact that only 13 patients over a 10-year period indicates that only a small percentage of these patients are candidates for surgery.

Management of patients with dysphagia due to ACO depends on the severity of symptomatology and the laboratory findings. The first line of treatment for these patients usually includes diet modification, swallowing therapy, anti-inflammatory drugs, and muscle relaxants. When these fail, surgery can be considered. Transcervical and transoral surgical approaches have been described for ACO removal. Transcervical approaches include anterolateral (AL) and posterolateral (PL) approaches. The AL approach provides better exposure of the carotid sheath and neurovascular bundle, but the recurrent laryngeal nerve is expected to be more at risk compared to the PL approach. The PL approach requires more retraction and the damage to sympathetic plexus is more common when using this approach. The transoral approach has the advantages of no skin incision and little risk of neurovascular damage. However, it has the disadvantages of limited exposure and potential risk for fasciitis or osteomyelitis due to pharyngeal contamination. The AL transcervical approach used in our patients was safe with no persistent neurovascular complication.

CONCLUSIONS

This study presents preoperative and postoperative functional and manofluorographic data of a series of patients undergoing surgery for ACO dysphagia. Functional improvement after surgery was reflected by the decrease in FOSS stages, whereas objective improvement after surgery was reflected by the significant decrease in IB-Gra. These findings supported high IB-Gra as a reliable objective indicator for surgical intervention for ACO dysphagia and IB-Gra as an appropriate parameter for follow-up after ACO removal. ACO removal via AL transcervical approach is a safe and highly effective treatment in appropriately selected patients.

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REFERENCES