Anterior Cervical Osteophyte Resection for Treatment of Dysphagia

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Abstract

Study Design: This was a retrospective cohort study.

Objectives: When anterior cervical osteophytes become large enough, they may cause dysphagia. There is a paucity of work examining outcomes and complications of anterior cervical osteophyte resection for dysphagia.

Methods: Retrospective review identified 19 patients who underwent anterior cervical osteophyte resection for a diagnosis of dysphagia. The mean age was 71 years and follow-up, 4.7 years. The most common level operated on was C3-C4 (13, 69%).

Results: Following anterior cervical osteophyte resection, 79% of patients had improvement in dysphagia. Five patients underwent cervical fusion; there were no episodes of delayed or iatrogenic instability requiring fusion. Fusion patients were younger (64 vs 71 years, \(P = .05\)) and had longer operative times (315 vs 121 minutes, \(P = .01\)). Age of 75 years or less trended toward improvement in dysphagia (\(P = .09\); OR = 18.8; 95% CI 0.7-478.0), whereas severe dysphagia trended toward increased complications (\(P = .07\); OR = 11.3; 95% CI 0.8-158.5). Body mass index, use of an exposure surgeon, diffuse idiopathic skeletal hyperostosis diagnosis, surgery at 3 or more levels, prior neck surgery, and fusion were not predictive of improvement or complication.

Conclusions: Anterior cervical osteophyte resection improves swallowing function in the majority of patients with symptomatic osteophytes. Spinal fusion can be added to address stenosis and other underlying cervical disease and help prevent osteophyte recurrence, whereas intraoperative navigation can be used to ensure complete osteophyte resection without breaching the cortex or entering the disc space. Because of the relatively high complication rate, patients should undergo thorough multidisciplinary workup with swallow evaluation to confirm that anterior cervical osteophytes are the primary cause of dysphagia prior to surgery.

Keywords
cervical spine, osteophyte, syndesmophyte, DISH, dysphagia, cheilectomy

Introduction

Anterior vertebral osteophytes and syndesmophytes are common radiological findings seen in the elderly adult population; yet they are rarely symptomatic.¹⁻³ These may be caused by spinal degeneration, previous trauma, prior surgery, or pathological conditions such as diffuse idiopathic skeletal hyperostosis (DISH).⁴⁻⁶ When these bony growths become large enough, they can lead to dysphagia, dysphonia, dyspnea, and obstructive sleep apnea.³⁻⁶⁻⁸

Osteophytes.⁵⁻⁹ Osteophytes may cause dysphagia via multiple mechanisms, including mechanical compression of the esophagus, interference with normal epiglottis movement,
compression of the Auerbach’s myenteric plexus, and the
induction of inflammation and edema about the esophagus,
which can lead to fibrosis and adhesions, preventing normal
motility and causing cricopharyngeal spasm.10,11 Most cases
can be treated nonsurgically with diet modification, muscle
relaxants, anti-inflammatories, postural changes during
eating, phonophoresis, and swallowing rehabilitation
programs.12,13 When conservative treatment fails, surgical
osteophyte resection can improve hyoid movement, leading
to enhanced upper esophageal sphincter opening11 and sym-
toms of dysphagia.3,6,7,11,14-24

Given the relative rarity of symptomatic anterior cervical
osteophytes being treated with surgical resection, the current
literature consists of case reports and case series with relatively
few patients.3,6,7,9,11,14-25 The purpose of this study was to
review demographics, clinical characteristics, preoperative
assessment, swallowing outcome, need for cervical fusion,
delayed cervical instability, and osteophyte regrowth following
primary resection of anterior cervical osteophytes as a treat-
ment for dysphagia at our tertiary referral center. We also
report our current preferred surgical workup and operative
technique using intraoperative navigation.

Materials and Methods
Following institutional review board approval, we identified
all patients who underwent anterior cervical osteophyte
resection for a diagnosis of dysphagia over an 18-year
period (1999-2017). This cohort was reviewed to determine
patient demographics, clinical presentation, preoperative
assessment, medical history, prior neck surgery, preopera-
tive spinal alignment and size of osteophytes/syndesmo-
phytes, swallowing function, and outcomes, including
intraoperative and postoperative complications, concomitant
cervical fusion, osteophyte regrowth, need for revision
osteophyte removal, and improvement in swallowing
function.

Preoperative swallowing function was measured using the
dysphagia severity scale described by Miyamoto et al16 and
the Functional Outcome Swallowing Scale (FOSS).16,26
Briefly, the dysphagia severity scale is graded as mild, mod-
erate, or severe based on swallowing symptoms. Mild dyspha-
gia was defined by abnormal sensation or painful swallowing,
moderate dysphagia as difficulty swallowing solid boluses,
and severe as unable to swallow small solid boluses or experi-
encing aspiration and coughing during swallowing.16 The
FOSS staging system defines stage 0 as normal function; stage
I, episodic or daily dysphagia; stage II, significant dietary
modifications or prolonged mealtimes; stage III, decompens-
sated function, with weight loss of 10% or less of body
weight; stage IV, severely decompensated, with weight loss
of more than 10% body weight or severe aspiration with
bronchopulmonary complications; and stage V, requiring
nonoral feeding.

Table 1. Demographics of Patients Undergoing Anterior Cervical
Osteophyte Resection for Dysphagia.

| Demographic               | Count (Percentage) |
|---------------------------|-------------------|
| Male patients             | 17 (89%)          |
| Female patients           | 2 (11%)           |
| Mean age (+SD) years      | 70.6 ± 7.7        |
| Mean BMI (+SD) kg/m²      | 26.4 ± 4.8        |
| Mean follow-up (+SD)      | 4.5 ± 2.0         |

Abbreviations: BMI, body mass index.

Patient Group
Over the study period, 19 patients underwent anterior cervical
osteophyte resection for a diagnosis of dysphagia. There were
17 (89%) men, with a mean age of 71 years and mean body
mass index (BMI) of 26.4 kg/m². There were 3 (16%) current
tobacco users and 10 (53%) former tobacco users. A preopera-
tive diagnosis of diabetes mellitus was present in 11% (2) of
patients. The mean length of preoperative dysphagia symp-
toms was 6.6 years. Mean clinical follow-up was 4.7 years
(range, 2-10 years; Table 1). A total of 16 patients had final
follow-up cervical spine imaging, with a mean of 2.4 years
(range, 2.5 months to 6.5 years), after surgery. Also, 16
patients underwent swallowing evaluation after surgery prior to
starting an oral diet. The most common spinal level operated
on was C3-4 (Figure 1), and the average number of levels
operated on was 2.6 ± 1.7 levels (range 1-6 levels). Seven
patients (37%) had a history of prior cervical spine or anterior
neck surgery, 12 patients (63%) had a diagnosis of diffuse
idiopathic skeletal hyperostosis (DISH), 1 patient (5%) had
a diagnosis of ankylosing spondylitis, and 1 patient (5%) had
rheumatoid arthritis.

Preoperative Assessment
Preoperative workup included video fluoroscopic swallowing
exam and evaluation by an otolaryngologist (100%),

Figure 1. Levels of anterior osteophyte resection in 19 patients
undergoing surgery for a diagnosis of dysphagia.
computed tomography (CT) scan (74%), magnetic resonance imaging (MRI; 73%), cervical spine X-rays (37%), electromyograph (5%), and evaluation by gastroenterology (47%), physical medicine and rehabilitation/speech (37%), and neurology (11%).

**Surgical Treatment**

Surgeries were performed by either a spine fellowship–trained orthopedic surgeon or neurosurgeon. An exposure surgeon trained in otolaryngology was utilized in 12 of the 19 cases (63%). All patients were positioned supine on a flat-top table and underwent general anesthesia. A Smith-Robinson approach with either a transverse or vertical oblique skin incision was utilized in all cases.6,27 In all joint cases, the otolaryngologist performed the exposure and the orthopedic spine or neurosurgery team performed the cheilecctomy with or without fusion. Osteophyte resection was completed using a combination of osteotomes, punches, rongeurs, and high-speed drill with a diamond or matchstick bur. Fluoroscopic imaging or surgical navigation was used intraoperatively to assist with removal of the osteophyte complex.

**Intraoperative Surgical Navigation**

The StealthStation Surgical Navigation System (Stealth) and O-Arm Surgical Imaging System (Medtronic, Dublin, Ireland) was used for intraoperative surgical navigation. A Mayfield cranial stabilization system (Integra LifeSciences, Plainsboro, NJ) is used to hold the skull and cervical spine in place during the operation and allow for placement of the reference frame attachment (Figure 2). Exposure and provisional osteophyte removal are completed prior to O-Arm imaging. This allows intraoperative 3-D imaging to determine which portions and how much of the osteophyte(s) remain after provisional resection. Navigated probes and burs are then used for final osteophyte resection to the native anterior vertebral body cortex without breaching the cortex or entering the disc space (Figure 3).

**Statistical Analysis**

Continuous variables between groups were analyzed using the Student *t*-test or Wilcoxon test; categorical variables were compared using the Fisher exact test; and odds ratios were calculated when feasible. Multivariate nominal logistic regression analysis of surgical and patient characteristics, including age
>75 years, BMI >27.5 kg/m², and preoperative dysphagia severity, was completed to determine impact on improvement in dysphagia and complications after surgery. A P value <.05 was considered significant for all statistical analyses.

Results

The average size of resected osteophytes was 14.2 mm (4-23.9 mm); 8 patients (42%) had the maximal size of the osteophyte at the C3-4 level, 8 (42%) at the C4-5 level, and 3 (16%) at the C5-6 level. Cheilectomy was performed at a single level in 7 patients, 2 levels in 5 patients, and 3 or more levels in 7 patients. Patients with a diagnosis of DISH underwent surgery at more levels than those patients without a DISH diagnosis (3.1 ± 2.0 vs 1.7 ± 0.8 levels; P = .05).

Prior to surgery, 7 patients (37%) had severe dysphagia, 11 (58%), moderate dysphagia, and 1 (5%), mild dysphagia (Table 2). There was no correlation between dysphagia severity and osteophyte size (P = .5) or number of levels operated on (P = .3). When dysphagia was measured using FOSS, 6 patients (32%) had stages II, III, and IV, each, whereas 1 patient (5%) had a stage of V. There was no correlation between FOSS and osteophyte size (P = .44) or number of levels operated on (P = .94). More than half of the patients (53%) reported significant weight loss prior to surgery (mean 11.8 lb; 0-40 lb).

Following anterior cervical osteophyte resection for a diagnosis of dysphagia, 15 of the 19 patients (79%) had a significant improvement in their dysphagia, 3 had some improvement (16%), and 1 had no improvement (5%; Figure 4). Mean time to improvement in dysphagia was 36 days (range 1-244 days). The average increase in BMI after surgery was 2.1 kg/m². Patients who underwent cheilectomy at C5-6 and below showed a 50% rate of improvement compared with a rate of improvement of 82% in patients who had osteophytes removed from the C4-5 level or above (P = .39). Patients <75 years old saw improvement in their dysphagia 93% of the time compared with only 40% in patients >75 years old. This was significant on univariate analysis (P = .04; OR = 19.5; 95% CI = 1.3-292.8) and trended toward significance on multivariate nominal logistic regression analysis (P = .09; OR = 18.8; 95% CI = 0.7-478.0). Use of an exposure surgeon, surgery at 3 or more levels, prior neck surgery, fusion at the time of cheilectomy, osteophyte regrowth, and DISH diagnosis were not found to be predictive of improvement on univariate analysis (Table 3). BMI >27.5 kg/m² and severe preoperative dysphagia were not independent prognostic factors on univariate or multivariate analysis (Table 4).

Five patients (26%) underwent cervical fusion in conjunction with the osteophyte resection (Figure 5). Four of these patients had a planned fusion for concomitant spinal stenosis with radiculopathy (25%), myelopathy (25%), or significant stenosis on MRI (50%). The fifth patient underwent fusion to prevent osteophyte recurrence, given the hyperlordotic alignment and multiple levels of fused segments below the construct. No patient underwent anterior spinal fusion for concerns of iatrogenic instability related to the osteophyte resection. The average preoperative cervical lordosis was 26.3° (−7° to 52.3°; Table 5). There was no significant difference in lordosis between those who underwent fusion and those who did not (36.7° vs 21.9°; P = .08). There was 1 patient with a C2-3 anterolisthesis who did not undergo fusion. All other patients did not have a cervical spondylolisthesis. The average...
Table 2. Patient Characteristics, Surgical Characteristics, Dysphagia Improvement, and Complications of Those Undergoing Primary Anterior Cervical Osteophyte Resection for Dysphagia.\textsuperscript{a}

| Patient | Age and Sex | Clinical Follow-up (Radiographic Follow-up, in Years) | Previous Surgery                                    | Dysphagia Severity and FOSS | Operative Levels Fusion | Improvement in Dysphagia | Osteophyte Regrowth | Complication                                                                                   |
|---------|-------------|--------------------------------------------------------|----------------------------------------------------|-----------------------------|------------------------|------------------------|---------------------|---------------------------------------------------------------------------------------------|
| 1       | 76, M       | 2.7 (2.7)                                              | Tracheostomy and anterior neck skin grafting       | Severe, IV                  | C3-C4                  | No                     | No                  | Left-sided vocal cord paralysis (chronic) and right-side vocal cord paresis (acute), PEG |
| 2       | 67, M       | 5.0 (5.0)                                              |                                                   | Moderate, II                | C3-C5                  | No                     | Yes                 | C3-4 and C4-5 (11 mm at 5 years)                                                             |
| 3       | 62, M       | 9.8 (1.8)                                              | Thyroidectomy                                      | Severe, IV                  | C3-C7                  | C3-7 PSF               | Yes                 | Pseudoarthrosis at C6-7, Esophageal injury leading to deep infection, diskitis/osteomyelitis, and pseudoarthrosis |
| 4       | 64, F       | 4.7 (4.0)                                              |                                                   | Moderate, III               | C2-T1                  | C5-6 ACDF              | Yes                 | Aspiration pneumonia                                                                       |
| 5       | 77, M       | 3.3 (2.2)                                              | C4-5 ACDF                                          | Severe, IV                  | C5-C6                  | No                     | Some                | C5-6 (12 mm at 2 years)                                                                      |
| 6       | 76, M       | 5.9 (0.9)                                              | Thyroid surgery                                    | Moderate, IV                | C3-C7                  | No                     | Yes                 | C4-5 (7 mm at 3.5 years)                                                                     |
| 7       | 71, M       | 6.1 (0.3)                                              |                                                   | Severe, V                   | C2-C3                  | No                     | Yes                 |                                                                                             |
| 8       | 70, M       | 6.2 (3.5)                                              |                                                   | Moderate, II                | C4-C5                  | No                     | Yes                 |                                                                                             |
| 9       | 66, M       | 7.2                                                    |                                                   | Moderate, III               | C4-C7                  | No                     | Yes                 |                                                                                             |
| 10      | 79, M       | 5.7 (5.0)                                              |                                                   | Moderate, III               | C3-C4                  | C3-4 ACDF              | Yes                 | C2-3 (6 mm at 5 years)                                                                      |
| 11      | 65, M       | 2.0 (0.3)                                              | C5-7 ACDF                                          | Moderate, II                | C5-C6                  | No                     | Yes                 |                                                                                             |
| 12      | 63, M       | 2.4 (1.3)                                              |                                                   | Moderate, II                | C4-C6                  | C4-5 ACDF              | Yes                 | PEG                                                                                         |
| 13      | 88, M       | 2.1 (0.3)                                              |                                                   | Severe, IV                  | C2-C7                  | No                     | Some                |                                                                                             |
| 14      | 75, M       | 2.1 (0.3)                                              |                                                   | Moderate, III               | C2-T1                  | No                     | Yes                 |                                                                                             |
| 15      | 67, F       | 7.3 (6.5)                                              | C5-6 ACDF                                          | Moderate, III               | C3-5                   | No                     | Some                | C2-3 and C3-4 (13 mm at 6.5 years)                                                         |
| 16      | 54, M       | 5.5 (5.0)                                              |                                                   | Mild, II                    | C2-6                   | C2-6 ACF               | Yes, and improved breathing                                                               | Aspiration pneumonia                                                                 |
| 17      | 75, M       | 5.1 (0.2)                                              |                                                  | Severe, III                 | C3-4 and C5-6          | No                     | Yes                 | Aspiration pneumonia                                                                         |
| 18      | 75, M       | 3.7                                                    |                                                   | Severe, IV                  | C3-4                   | No                     | Yes                 | Superior laryngeal nerve injury with dysphonia                                              |
| 19      | 72, M       | 2.6                                                    |                                                   | Moderate, III               | C3-5                   | No                     | Yes                 |                                                                                             |

Abbreviations: FOSS, Functional Outcome Swallowing Scale; M, male; F, female; PEG, percutaneous endoscopic gastrostomy; PSF, posterior spinal fusion; ACDF, anterior cervical discectomy and fusion; ACF, anterior cervical fusion.

\textsuperscript{a}Bold text in the Osteophyte Regrowth column indicates asymptomatic regrowth of osteophytes.
motion of the cervical segment with the largest osteophyte that underwent resection was $3.1^\circ \pm 2.2^\circ$. There was no difference between motion of the cervical spine in those who underwent fusion and those who did not ($3.2^\circ$ vs $3.1^\circ$, $P = 1$). There was no difference in the osteophyte size, length of dysphagia, DISH diagnosis, or BMI between those undergoing fusion and those who did not; however, the fusion group was significantly younger (64 vs 73 years, $P = .05$). The use of a cervical collar after surgery was significantly increased in the fusion group (80% vs 14%; $P = .01$; OR = 24; 95% CI = 1.7-341.0).

The overall complication rate for this cohort was 42%. There were no episodes of delayed instability requiring fusion; however, there was 1 pseudoarthrosis that was lost to follow-up after 2 years. This patient underwent a C3-7 posterior spinal fusion for coexisting myelopathy and developed a pseudoarthrosis at the bottom of the construct at C6-7. There was also a case of pseudoarthrosis of a C5-6 anterior cervical discectomy and fusion (ACDF) with deep infection with diskitis and vertebral osteomyelitis, where the patient underwent a 2-stage anterior-posterior fusion with irrigation, debridement, and

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**Figure 4.** Imaging of patients who did not see significant improvement in their dysphagia after anterior cervical osteophyte resection. Axial computed tomography (CT) scan through the C4 vertebral body preoperatively (A) and 2 months postoperatively of patient 1 showing minimal residual anterior osteophyte and decreased esophageal compression. Lateral X-rays of patient 13, preoperatively (C) and 1 month postoperatively (D) showing full resection of osteophytes. Radiographic imaging of patient 5 who had a 16-mm osteophyte at C5-6 preoperatively (E), 6 mm postoperatively (F), and osteophyte regrowth to 11.5 mm 2 years postoperatively (G). CT imaging of patient 15 who had a 16.5 mm osteophyte at C3-4 preoperatively (H), 8 mm 14 months postoperatively (I), and regrowth to 13 mm at 6.5 years after osteophyte resection (J).
revision C5-6 ACDF with iliac crest bone graft and posterior cervical fusion from C5-T1. Of note, this patient also underwent myotomy of the esophagus at the time of cheilectomy, leading to esophageal injury. This patient ultimately went on to clear the infection and develop a stable fusion after reoperation. There was 1 case of bilateral vocal cord dysfunction. This patient had a history of anterior neck and chest burns requiring tracheostomy and skin grafting 40 years prior. They had chronic left vocal cord paralysis and acquired a right vocal cord paresis after osteophyte resection (via a right-sided approach). This patient required percutaneous endoscopic gastrostomy (PEG) placement 9 days postoperatively. His right vocal cord paresis improved, and he was weaned from PEG feeds by 8 months. One patient had a PEG tube in place before surgery, and one other required PEG tube placement during their recovery. All patients had their PEG tube removed within 9 months of surgery. One patient had a tracheostomy prior to surgery, which too was removed after cheilectomy. No patient in this cohort required tracheostomy after cheilectomy. Other complications included 1 superior laryngeal nerve injury and 2 cases of aspiration pneumonia. There were no patients who underwent a revision anterior osteophyte resection. Severe dysphagia prior to surgical intervention trended toward an increased risk of complications on univariate analysis (71\% vs 25\%; \( P = .07\); OR = 7.5; 95\% CI = 0.9-61.1), whereas a BMI >27.5 kg/m², age of 75 years or less, use of an exposure surgeon, surgery at 3 or more levels, prior neck surgery, fusion at the time of cheilectomy, osteophyte regrowth, or DISH diagnosis did not appear to relate to complications (Table 3).
dysphagia again trended toward increased risk of complications (OR = 11.3; 95% CI = 0.8-158.5), whereas a BMI >27.5 kg/m² and an age >75 years were less predictive of complication (Table 4).

There were 5 (26%) cases of osteophyte regrowth, one of which underwent fusion. Mean regrowth was $2.0 \pm 0.5$ mm per year in these patients. Three patients had asymptomatic osteophytes measuring 11 mm at 5 years, 6 mm at 5 years (proximal level to osteophyte resection and ACDF), and 7 mm at 3.5 years after surgery (Figure 6). Another patient had osteophyte regrowth seen 14 months after surgery measuring 8 mm (this patient did not have postoperative X-rays, so some of this bony osteophyte may have been from incomplete resection) and 13 mm at 6.5 years postoperatively (Figures 4H-4J). This patient had some improvement after surgery but continued to complain of progressive dysphagia over the next few years and ultimately underwent an esophageal dilation 8 years after her osteophyte resection. The final patient with regrowth had 6 mm of residual osteophyte postoperatively, which grew to 11.5 mm 2 years postoperatively (Figures 4E-4G). This patient

Figure 5. Five patients underwent concurrent cervical fusion surgery along with osteophyte resection. Lateral preoperative (A) and 2-year postoperative (B) X-rays for patient 3 who underwent C3-7 osteophyte resection and posterior decompression and fusion for concurrent myelopathy. Preoperative (C) and 5-year postoperative (D) lateral X-rays of patient 10 who underwent C3-4 anterior cervical discectomy and fusion (ACDF) for critical cervical stenosis at the time of osteophyte removal. Preoperative (E) and 2-year postoperative (F) X-rays of patient 12, who underwent prophylactic C4-5 ACDF to help prevent recurrent osteophyte regrowth. Lateral preoperative (G) and 5-years postoperative (H) X-rays of patient 17 who underwent C5 corpectomy with C2-6 anterior cervical fusion for cervical stenosis from OPLL along with osteophyte removal of dysphagia and sleep apnea. Preoperative (I) and postoperative (J) X-rays of patient 4 who underwent C5-6 ACDF for C6 radiculopathy along with C2-T1 cheilectomy and cricopharyngeal myotomy for dysphagia. The patient developed a postoperative infection with osteomyelitis, requiring a 2-stage operation with anterior debridement, with partial C5 and C6 corpectomy, revision C5-6 ACDF, and posterior C5-T1 spinal fusion, which showed good alignment 4 years postoperatively (K).
Table 5. Characteristics of Patients Undergoing Anterior Osteophyte Resection for Dysphagia With Comparison of Those Undergoing Fusion and Those Not Undergoing Fusion.

| Characteristic                  | Combined          | Fusion           | No Fusion        | P Value |
|--------------------------------|-------------------|------------------|------------------|---------|
| Osteophyte size (mm)           | 14.2 ± 4.8        | 15.6 ± 3.7       | 13.6 ± 5.2       | .43     |
| Length of dysphagia (years)    | 3.6 ± 3.7         | 3.0 ± 2.0        | 3.8 ± 4.2        | 1.00    |
| Cervical lordosis (degrees)    | 26.3 ± 13.8       | 36.7 ± 12.7      | 21.9 ± 12.2      | .07     |
| Motion at osteophyte segment   | 3.2 ± 2.3         | 3.2 ± 2.3        | 3.3 ± 2.5        | 1.00    |
| Age (years)                    | 70.6 ± 7.7        | 64.4 ± 9.1       | 72.9 ± 6.0       | .05     |
| BMI (kg/m²)                    | 26.4 ± 4.8        | 28.8 ± 3.6       | 25.5 ± 5.0       | .21     |
| Cervical collar use            | 6 (31.6%)         | 4 (80.0%)        | 2 (14.3%)        | .01     |
| DISH diagnosis                 | 12 (63.2%)        | 4 (80.0%)        | 8 (57.1%)        | .36     |
| Operative time (minutes)       | 178 ± 137         | 315 ± 174        | 121 ± 67         | .01     |
| EBL (cc)                       | 162 ± 156         | 245 ± 233        | 117 ± 75         | .63     |
| Length of stay (days)          | 3.3 ± 2.3         | 4.2 ± 2.0        | 3.0 ± 3.6        | .07     |

Abbreviations: BMI, body mass index; DISH, diffuse idiopathic skeletal hyperostosis; EBL, estimated blood loss.

Discussion

Anterior osteophytes occur commonly along the length of the spine; however, when they occur in the tight confines of the neck, they can produce symptomatic mass effect on the adjacent structures, leading to dysphagia. The purpose of this study was to review our experience with primary anterior osteophyte resection and report our current preferred surgical workup and operative technique.

Here, we report that the majority (79%) of patients had significant improvement in dysphagia after surgical resection of anterior cervical osteophytes. This is similar to previous studies, which have shown improvement in 70% to 100% of patients.\(^6,14,16,20,22,28\) Patients 75 years or older trended toward less improvement, which may be a result of increased frailty and decreased functional reserve in these patients.\(^29\) Additionally, those who failed to improve after surgery had multifactorial dysphagia, including vocal cord dysfunction, esophageal dysmotility and weakness, altered peristalsis, and esophageal strictures, along with anterior cervical osteophytes. This highlights the importance of a thorough preoperative evaluation because it is important to rule out other causes of dysphagia, which should be treated prior to osteophyte resection. Additionally, if patients have other factors contributing to dysphagia, preoperative counseling is key to managing expectations regarding dysphagia improvement.

Previous studies have described failure resulting from incomplete resection of osteophytes and osteophyte regrowth.\(^16,23\) In this cohort, there were 5 patients (2 symptomatic and 3 asymptomatic) who showed osteophyte regrowth after osteophyte resection. However, previous studies have shown that it can take 10 or more years to become symptomatic from osteophyte regrowth.\(^16\)

Some studies have advocated for prophylactic cervical fusion in patients <70 years of age to prevent regrowth of osteophytes.\(^16\) We found regrowth to be 2 mm per year in those who had osteophyte regrowth, which is higher than that previously reported (1 mm per year).\(^16\) In this cohort, coexisting spinal stenosis and spinal cord or nerve root impingement was the most common reason for fusion, whereas 1 patient underwent fusion to prevent regrowth. Previous studies have suggested the use of nonsteroidal anti-inflammatory drugs to prevent osteophyte recurrence; however, the value of this has not been elucidated.\(^16,22,30\)

Likewise, application of bone wax to the exposed cut bone helps with hemostasis and may reduce the rate of bone reaccumulation.\(^31,32\)

This is the first study to describe the use of intraoperative navigation for the resection of anterior cervical osteophytes, which has multiple advantages. Following provisional resection, intraoperative 3-D scanning can determine the amount and location of remaining osteophytes, whereas navigated probes and burs allow for real-time guidance during final bony resection. Navigation also allows the surgeon to “visualize” the native disc space and remove bridging osteophytes anterior to the disc space without entering it or damaging the annulus fibrosis. This prevents iatrogenic destabilization requiring fusion or late instability, which would require subsequent surgery and fusion. Surgical navigation does, however, come at the expense of increased cost and surgical time for intraoperative imaging and the learning curve inherent to surgical navigation.\(^33-36\)

In this cohort, the most symptomatic level of cervical osteophytes was C3-4 followed by C4-5 and C5-6. All osteophytes resected at the C6-7 and C7-T1 level were in conjunction with...
osteophyte complexes higher in the cervical spine. Osteophytes at C3-4 and C4-5 have been shown to restrict laryngeal closure by the epiglottis and at C5-6 and C6-7 lead to the retention of solid food in the pharynx, both of which can result in aspiration.\(^\text{16,18}\) Additionally, osteophytes at the C5-6 level and below have more room for growth without impingement on the esophagus because the soft-tissue space between the anterior spine and the esophagus measures approximately 6 mm at C2 and 22 mm at C6.\(^\text{37}\) For these reasons, osteophytes below the C4-5 levels are less likely to cause dysphagia, and improvement after

Figure 6. Preoperative (A) radiograph of patient 2, who underwent C3-5 anterior osteophytectomy (21 mm) with postoperative radiograph (B) demonstrating complete excision of the C3-4 and C4-5 osteophyte and subsequent asymptomatic regrowth of osteophytes to 11 mm (C) at the 5-year follow-up. Preoperative (D) radiographs of patient 10 who underwent C3-4 anterior cervical discectomy and fusion and cheilectomy (E) who had regrowth of osteophytes (6 mm) proximally at the C2-3 level at the 5-year follow-up. Preoperative T2 magnetic resonance image (G) of patient 8 who underwent C4-5 osteophyte resection (13 mm) and had asymptomatic regrowth of osteophytes at C4-5 of 7 mm at the 3.5-year follow-up (H).
resection is less predictable (82% vs 50% improvement in this series).

Our preferred management of these patients includes a multidisciplinary approach involving otolaryngology and speech pathology preoperatively to evaluate for other causes of dysphagia. All patients should have preoperative flexion and extension radiographs to evaluate for instability, spondylolisthesis, osteophyte size, and location. CT and MRI are adjunct studies used to help with preoperative planning and evaluate for spinal stenosis or nerve root impingement in those with symptoms of radiculopathy or myelopathy on exam because this should be addressed at the same time as osteophyte resection. Surgical exposure is typically completed by our otolaryngology colleagues given the more challenging exposure in the upper cervical level with the dramatic changes in anatomy caused by the large osteophytes. Likewise, this allows the otolaryngologist to have direct intraoperative anatomical knowledge of the esophagus and perform laryngoscopy/esophagoscopy if there is question regarding perforation or thinning of the posterior esophageal wall. Intraoperative navigation is used to ensure complete osteophyte resection and to avoid entering the disc spaces at levels where fusion is not planned. We believe that fusion should be considered in those patients with concomitant spinal cord/nerve root compression or spondylolisthesis or young patients with significant mobility at the cervical levels in question. Older patients with nonmobile segments can forgo fusion because this may increase operative times and complications for an already vulnerable population. Postoperative care should involve close monitoring of dysphagia and airway compromise. If there are airway concerns, delayed extubation and intensive care unit monitoring is warranted. All patients remain NPO (nothing by mouth) until after video swallow study to ensure safe swallowing prior to advancing the patient’s diet. It is not uncommon to use a temporary nasogastric feeding tube in patients with severe and prolonged preoperative dysphagia. The need for short-term and possibly long-term tube feeding must be discussed during preoperative counseling, along with the risk of esophageal injury and superior and recurrent laryngeal nerve palsy. Follow-up should include postoperative X-rays and follow-up X-rays every 3 to 5 years or if new dysphagia symptoms arise.

Limitations of this study include biases inherent to a retrospective review of a rare condition and the relatively low number of patients; however, this is the largest series to date. Additionally, not all patients had long-term follow-up cervical imaging to evaluate for osteophyte regrowth. Similarly, not all patients had flexion-extension radiographs to evaluate postoperative instability, although no patient has subsequently returned for cervical fusion to address instability or stenosis symptoms. Although our duration of radiographic follow-up (2.4 years) limits our ability to empirically comment on potential for recurrent anterior osteophytosis, symptomatic recurrence has not been our anecdotal experience. This may be a result of the fact that the many patients presenting with dysphagia (such as patient 13; Figures 4C-4D) have developed large anterior osteophytes in the context of generalized advanced spondylosis and resultant ankyloses, in which disc collapse as well as uncovertebral and facet arthroses are created. Resecting anterior osteophytes does not undo this generalized stiffening, and no patient required revision surgery for recurrent dysphagia. Finally, there was no postoperative scoring system or patient-reported outcome (PRO) utilized for these patients after surgery to evaluate quantitative change after osteophyte resection. Future studies should incorporate both preoperative and postoperative PRO measures such as the Swallow Quality of Life Questionnaire, Sydney Swallow Questionnaire, or Swallowing Quality of Care, which are high-quality PRO measures for mechanical and neuromyogenic oropharyngeal dysphagia.

In conclusion, anterior cervical osteophyte resection improves swallowing function in the majority of patients with dysphagia caused by esophageal compression. Prior to surgery, patients should undergo thorough swallow evaluation to ensure that the anterior cervical osteophytes are the primary cause of dysphagia, whereas the use of intraoperative navigation confirms complete resection. Additionally, there is a relatively high complication rate, which highlights the need for a multidisciplinary approach to the workup and treatment of these patients.

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