Anterior cervical osteophytes causing dysphagia: Choice of the approach and surgical problems

ABSTRACT

Background: Anterior cervical osteophytes (ACOs) may rarely cause dysphagia, dysphonia, and dyspnea. Symptomatic ACOs are most commonly located between C3 and C7, whereas those at higher cervical (C1–C2) levels are rarer. We report a case series of 4 patients and discuss the best surgical approach according to the osteophyte location and size, mainly for those located at C1–C2, and the related surgical problems.

Materials and Methods: Four patients (two males and two females) aged from 57 to 72 years were operated on for ACOs, causing variable dysphagia (and dyspnea with respiratory arrest in one). Three patients with osteophytes between C3 and C5 were approached through antero-lateral cervical approach, and one with a large osteophyte between C1 and C3–C4 level underwent a two-stage transcervical and transoral approach. All had significant postoperative improvement of dysphagia.

Results: The patient operated on though the transoral approach experienced postoperative flogosis of the prevertebral tissues and occipital muscles and thrombosis of the right jugular vein and transverse-sigmoid sinuses (Lemierre syndrome).

Conclusion: The transoral approach is the best surgical route to resect C1 and C2 ACOs, whereas the endoscopic endonasal approach is not indicated. The anterior transcervical approach is easier to resect osteophytes at C3, as well as those located below C3. A combined transoral and anterior cervical approach may be necessary for multilevel osteophytes.

Keywords: Anterior cervical osteophytes, cranio-vertebral junction, dysphagia, transcervical approach, transoral approach

INTRODUCTION

Anterior cervical osteophytes (ACOs) are common radiological findings of the elderly, with an incidence of 20%–30% in over 60 years old patients. They are usually small and asymptomatic or associated with a specific neck pain. However, when they reach a large size, they may cause dysphagia, globus sensation, and more rarely dysphonia and dyspnea. The incidence of dysphagia in patients with ACOs is variable according to the patient’s age (1% at all ages and 10.6% of patients 60 years old or older observed for dysphagia evaluation).

Symptomatic ACOs causing dysphagia are more commonly found at the C4–C7 levels and rarely at higher cervical levels (with only 7 out of 68 patients showing the involvement of C1 in a case series).

Access this article online

Website: www.jcvjs.com

DOI: 10.4103/jcvjs.JCVJS_147_20

This is an open access journal, and articles are distributed under the terms of the Creative Commons Attribution-NonCommercial-ShareAlike 4.0 License, which allows others to remix, tweak, and build upon the work non-commercially, as long as appropriate credit is given and the new creations are licensed under the identical terms.

For reprints contact: WKHLRPMedknow_reprints@wolterskluwer.com

How to cite this article: Maiuri F, Cavallo LM, Corvino S, Teodonno G, Mariniello G. Anterior cervical osteophytes causing dysphagia: Choice of the approach and surgical problems. J Craniovert Jun Spine 2020;11:300-9.
The surgical approach and resection of symptomatic ACOs mainly depend on their location in height and size.

This study reports four surgical cases of ACOs, causing dysphagia and discusses the surgical problems and the best approach according to the osteophyte location.

MATERIALS AND METHODS

Four patients who complained of dysphagia due to ACOs, operated on in our neurosurgical unit, were reviewed retrospectively. None of them had a history of trauma, neurological and rheumatologic diseases, previous surgery, or infection.

All four patients were studied by computerized tomography (CT) of the cervical spine and barium swallow study and three also by the magnetic resonance of the cervical spine [Figures 1-3]. In all four cases, these studies excluded other causes of dysphagia.

The case records, diagnostic studies, surgical descriptions, and postoperative clinical and radiological data were analyzed. The dysphagia was graded according to the “Functional Outcome Swallowing Scale” (FOSS) described by Salassa[7][9] [Table 1]. The analyzed factors were patient age and sex, grade of dysphagia, presence of other related symptoms, location and size of the osteophyte, surgical approach and resection, complications, and clinical outcome.

In all patients, the conservative treatment, including swallowing therapy, anti-inflammatory, myorelaxing, and antireflux treatment were administered for 3 months before the surgical operation, with no clinical improvement.

The follow-up ranges from 3 months to 6 years.

RESULTS

The data of the four patients are summarized in Table 2. The patients were 2 men and 2 women, with age ranging from 57 to 72 years (average 65 years). All four patients complained of dysphagia for solid and two also for liquid foods, with FOSS grade ranging from 2 to 4; all also had unspecified cervical pain, variable reduction of the neck movements, pharyngeal irritation, and sensation of foreign body in the throat. One patient (case 4) also had weight loss and slight occasional dyspnea. Finally, one patient complained of significant dyspnea and experienced respiratory arrest requiring an urgent tracheostomy.

The osteophyte was located between C3 and C5 in three patients, whereas another had a large osteophyte extending between C1 and C3–C4 discal space.
The surgical approach was transcervical antero-lateral in three cases with osteophyte located between C3 and C5 (from the right side in two cases and from the left side in one, according to the greater extension of the osteophyte). An horizontal skin incision allowed to obtain sufficient longitudinal muscle opening to well expose the upper and lower margin of the osteophyte. The microsurgical resection was made by a high-speed drill up to the base of the osteophyte.

In a patient with an osteophyte extending between C1 and C3–C4 level, a combined two-stage right transcervical and transoral approach was necessary; in fact, because of the narrow mouth opening and the hypertrophic tongue, the only transoral approach was considered insufficient.

The transoral approach was made with the patient in the supine position with intubation through a prophylactic tracheostomy and with the head secured in a Mayfield fixation. A dedicated transoral system was used for the approach. The osteophyte was found to occupy the mouth cavity [Figure 4a]. A longitudinal midline incision of the posterior pharyngeal wall allowed to expose the osteophyte which was resected by drilling [Figure 4b] up to visualize the partially preserved anterior longitudinal ligament [Figure 4c].

In all four patients, the osteophyte was largely excised up to obtain a smooth spinal curve. Intraoperative X-ray studies were performed in all cases to confirm the resection. No spinal fusion was made.

No major immediate postoperative complications, such as laryngeal damage, esophageal perforation or major vascular injury, occurred. However, patient 4 operated on by combined transcervical and transoral approach experienced, 1 month after the transoral surgery, severe neck pain, and fever.

### Table 1: Functional outcome swallowing scale

| Stage | Symptoms                                                                 |
|-------|--------------------------------------------------------------------------|
| 0     | Normal physiologic function without symptom                               |
| 1     | Normal function with daily or episodic symptoms of dysphagia            |
| 2     | Decompensated abnormal function manifested by significant diet mismatches or prolonged meal time (without weight loss or aspiration) |
| 3     | Severely decompensated abnormal function with weight loss of more than 10% of body weight over 6 months due to dysphagia; or daily cough, gagging, aspiration during meals |
| 5     | Nonoral feeding for all nutrition                                         |

### Table 2: Summary of clinical and surgical data of 4 patients with anterior cervical osteophytes causing dysphagia

| Patients/age/sex | Level | Diagnostic studies | Surgical approach | Fusion | Complications | FOSS | Respiratory symptoms |
|------------------|-------|--------------------|-------------------|--------|---------------|------|----------------------|
|                  |       |                    |                   |        |               | Preoperative | Postoperative | Difference | Preoperative | Postoperative | |
| 1 57 male        | C5 CT scan BSS | Right transcervical antero-lateral | No | None | 3 | 0 | −3 | Dyspnea, respiratory arrest, tracheostomy | Remission |
| 2 62 female      | C4-5 MRI CT scan BSS | Right transcervical antero-lateral | No | None | 2 | 0 | −2 | None | - |
| 3 68 male        | C3 MRI CT scan BSS | Left transcervical antero-lateral | No | None | 3 | 1 | −2 | None | - |
| 4 72 female      | C1-3 MRI CT scan BSS | Right transcervical antero-lateral + transoral (two stage) | No | Prevertebral tissue inflammation right jugular vein thrombosis | 4 | 1 | −3 | Slight occasional dyspnea | Remission |

BSS - Barium swallow study, CT - Computed tomography, MRI - Magnetic resonance imaging, FOSS - Functional outcome swallowing scale
Radiological studies evidenced flogosis of the paravertebral tissues and occipital muscles and thrombosis of the right jugular vein and transverse-sigmoid sinuses. This condition was diagnosed with Lemierre syndrome,[8,9] due to infection from *Streptococcus constellatus*. Complete clinical remission of the infectious complication was obtained by antibiotic and anticoagulant therapy.

The clinical outcome was as follows. Dysphagia disappeared or significantly improved from 2 to 3 grades of the FOSS scale [Table 2]. In one patient, who experienced respiratory arrest, the tracheostomy was removed 2 months after the surgery and the respiratory function returned to be normal.

**DISCUSSION**

ACOs may sometimes become symptomatic with different mechanisms, including mechanical compression of the pharynx and esophagus, periosteophyte and pharyngo-esophageal inflammation, fibrosis, displacement of the laryngeal structures, and pharyngeal spasm.[10-13] Dysphagia is the main and more frequent complaint; dyspnea, dysphonia, and hoarseness are rarer.

Patients with ACOs and dysphagia should be first treated conservatively with swallowing therapy, anti-inflammatory and myorelaxing drugs. These therapies result in long-term clinical improvement or remission in many cases.

The surgical treatment of ACOs with the aim to resolve the dysphagia was suggested for about 60 years, as confirmed by some literature reviews.[14-16] More frequent mid- or low cervical osteophytes were treated by standard anterolateral cervical approach; those located in the high cervical region, significantly less frequent, were approached through the transoral route. Besides, other endoscopic approaches, such as endonasal and cervical, should be evaluated.

### Anterolateral cervical approach

The standard anterolateral cervical approach is used in most patients. We have reviewed 67 studies reported in the literature of the past 25 years, which include patients with symptomatic ACOs treated by this approach.[11-13,17-80] Nineteen studies[29,30,34,38,39,49-51,54,56,62,63,67,69,73,76-78,80] report series of 4 or more patients while the others are reports of one to three patients. An overall number of 198 patients have been collected.

The data of the 198 reviewed cases are summarized in Table 3. These show a significant prevalence of men (91% vs. 9%), mainly aged between 60 and 80 years. Most patients had involvement of one to 3 levels, mainly from C3 to C6. High C2–C3 (7%) and low C7–T2 (5%) osteophytes were rare; besides, there were no lesions extending to C1.

| Covariates | Number of cases (%) |
|------------|---------------------|
| **Patient sex** |                     |
| Male       | 180 (91)            |
| Female     | 18 (9)              |
| **Age (years)** |                   |
| <50        | 11 (6)              |
| 51-60      | 28 (14)             |
| 61-70      | 82 (41)             |
| 71-80      | 63 (32)             |
| >80        | 14 (7)              |
| **Number of involved levels for each patients** |     |
| 1          | 72 (37)             |
| 2          | 40 (20)             |
| 3          | 40 (20)             |
| 4          | 26 (13)             |
| 5–6        | 20 (10)             |
| **Involved spine level (in 174 pts)** |     |
| C2–C3      | 32 (7)              |
| C3–C4      | 99 (22)             |
| C4–C5      | 124 (28)            |
| C5–C6      | 105 (24)            |
| C6–C7      | 60 (14)             |
| C7–T1      | 16 (4)              |
| T1–T2      | 4 (1)               |
| **Symptoms** |                   |
| Dysphagia  | 183 (92)            |
| Dyspnea    | 39 (20)             |
| Neck pain  | 24 (12)             |
| Dysphonia  | 17 (9)              |
| Hoarsness  | 7 (3.5)             |
| Myelopathy | 6 (3)               |
| **Diagnostic studies** |       |
| Barium swallowing study | 90 (45) |
| X-ray of the cervical spine | 142 (71.5) |
| Cervical computerized tomography | 138 (69.5) |
| Cervical magnetic resonance | 83 (44) |
| Spinal fusion | 35 (17.5) |
| Tracheostomy | 17 (8) |
| **Postoperative complications** |       |
| Hematoma of the surgical field | 6 (3) |
| Laryngeal nerve palsy | 2 (1) |
| Epidural abscess | 1 (0.5) |
| Wound infection | 1 (0.5) |
| Complete aphagia | 1 (0.5) |
| Stroke | 1 (0.5) |
| **Outcome** |                   |
| Remission or variable improvement | 190 (96) |
| Unchanged or worsening | 8 (4) |

### Table 3: Data of 198 reviewed patients with anterior cervical osteophytes treated by anterolateral transcervical approach (1995–2020)
Dysphagia was the main complaint (92%); 39 patients (20%) presented variable dyspnea requiring perioperative tracheostomy in 17. Chronic neck pain (12%) and dysphonia (9%) were less frequent.

Preoperative diagnostic studies included barium swallowing study (45%), cervical spine X-ray (71.5%), CT (69.5%), and magnetic resonance (44%) of the cervical spine. An anterior spinal fusion was associated after the osteophyte resection in 35 patients (17%).

Postoperative complications included hematoma of the surgical field in 6 cases (3%) (requiring reoperation in 4), laryngeal nerve palsy in 2 (1%), complete aphagia in one, wound infection, epidural abscess, and stroke in one, respectively. No other major complications (esophageal perforation or major vessel injury) are reported.

Remission or variable improvement of dysphagia and other symptoms are reported in 96% of the patients, whereas 4% were unchanged or worsened.

Data on regrowth and recurrence are missed in most studies because of the short follow-up. Some studies report no regrowth after a median follow-up of about 2 years[62,73] and initial regrowth at median follow-up of 53 months[81] on the other hand, in their series of 7 cases with follow-up from 6 to 13 years Miyamoto et al.[49] report radiological recurrence in all cases with related symptoms in two. Thus, it seems that the osteophyte recurrence is not a negligible problem in the long-term follow-up, mainly in younger patients. Suggested prophylactic measures include therapy with indomethacin, additional anterior stabilization, and radiotherapy.[49,67,77] However, there are no precise guidelines.

We agree that all patients should be explored preoperatively by barium swallow study with the aim to confirm that the dysphagia is mechanical due to osteophytic compression. The diagnostic protocol should also include CT and magnetic resonance, to better define the osteophyte and exclude its extension into the spinal canal. On the other hand, the X-ray of the cervical spine, used as a unique diagnostic study in several reviewed otolaryngological series, is not sufficient.

The anterolateral cervical approach requires a greater longitudinal opening of the muscle planes to expose the frequent multilevel osteophytes. For strictly median osteophytes, the side of the approach may be decided according to the surgeon preference. Osteophytes with significantly asymmetric growth should be approached by the side of the greater growth to reduce the risk of damaging the esophagus displaced contralaterally. The dissection must be careful because of the adhesions of the osteophyte with the surrounding tissues and esophagus due to the lack of normal anterior longitudinal ligament. Intraoperative X-ray controls (or CT if available) are necessary to define the entity of the bone resection.

The need for fusion, performed in 35 (17.5%) of the reviewed cases, is controversial. Anterior fusion with interbody cage and/or anterior cervical plate is suggested to prevent instability and osteophyte regrowth.[49,62] However, it requires the dissection, the most extensive dissection of the prevertebral tissues, and longer surgical time. Thus, in agreement with most reviewed studies, we did not perform fusion in our patients.

**Transoral approach**

Anterior osteophytes located at C1 and C2 are better approached by the transoral route.[60,81] This approach through the incision of the posterior pharyngeal wall in the midline, allows direct exposure to the osteophyte protruding in the mouth cavity. This is associated with low risk of damaging the main vascular structures, the vagus, and laryngeal nerves.[82]

The transoral approach to the high cervical osteophytes is reported only in five studies.[20,24,69,81,83] On the other hand, even a large series of patients treated by transoral approach to the cervical spine for different pathologies do not include cases of osteophytes or diffuse skeletal hyperostosis.[84,85] The large study of 533 transoral operations by Choi and Crockard[86] does not focus on anterior osteophytes. Besides, in the literature review by Verlaan et al.[16] including 134 surgical cases of cervical osteophytes reported between 1980 and 2010, only one study includes a patient treated by transoral approach.[19]

The data of the 12 reviewed patients with anterior osteophytes of the high cervical region treated by transoral approach are summarized in Table 4.[20,24,69,81,83] Differently from those located below C3, a female prevalence (8 among 12 cases) is evidenced. Dysphagia was referred to in 9 cases, odynophagia in 3, and dysphonia in 3. The transoral technique was microsurgical in 5 cases and endoscopic in 7. The postoperative complications include cervical instability in one case ad infection in another. Clinical improvement or remission occurred in all cases.

The intraoperative surgical problems related to the osteophyte resection by the transoral approach deserve to be discussed [Table 5].
The transoral approach is commonly used for different pathologies, including rheumatoid arthritis, impressio basilaris, developmental anomalies C0–C2, fractures C1–C2, chordomas, and other tumors. Almost all these lesions, except for several tumors, are located within the vertebral bodies, posterior to the anterior longitudinal ligament, and do not protrude in the mouth cavity and pharynx. Thus, a rather wide working area is available. On the other hand, symptomatic ACOs are often large; they variably protrude in the mouth cavity and pharynx. Thus, a rather wide exposure of the transoral approach is 15–20 mm bilaterally,\cite{82,87} thus, if the osteophyte extends in the paramedian region, further lateral exposure may involve the risk of damaging the hypoglossal nerve and the vertebral artery. The intraoperative X-ray control is particularly important during the transoral approach because of the difficulty to define the depth of the resection and the lack of the surgical landmark of the anterior vertebral surface, as for the anterolateral approach.

If the bone resection is limited to the osteophyte, by sparing the anterior longitudinal ligament (if still present), the vertebral bodies and the C2–C3 disc, the posterior fusion, often advised for transoral approaches for other pathologies, is not necessary.

Although the video-assisted endoscopy may be useful to better visualize the blind angles around the osteophyte,\cite{81,83} the transoral approach cannot be used in patients with mouth opening of <3 cm. The lateral

### Table 4: Data of 12 reported cases of anterior cervical osteophytes treated by transoral approach

| Authors/year         | Age/sex | Symptoms                | Level       | Diagnostic studies | Surgical technique | Complications | Outcome    |
|----------------------|---------|-------------------------|-------------|--------------------|--------------------|---------------|------------|
| Ramadass et al., 1997\cite{21} | 31 Male | Dysphagia, dyspnea      | C1- C2      | X-ray, laryngoscopy| Microsurgical      |               | Improved   |
| Motsch et al., 1999\cite{23} | 54 Male | Dysphagia               | C2          | X-ray, CT          | Microsurgical      |               | Improved   |
| Erdur et al., 2017\cite{29} | 56 Male | Dysphagia               | C2- C3      | BSS                | Microsurgical      |               | Improved   |
| 58 Female            | Dysphagia| C2- C3                  | BSS         |                    | Microsurgical      |               | Improved   |
| Jabarkheel et al., 2018\cite{31} | 56 Female | Dysphagia, dysphonia   | C2- C3      | BSS                | Microsurgical      |               | Improved   |
|                      |         |                         | C1- C2      | CT, transoral      | Endoscopic         |               | Remission  |
| n.a Female          | Dysphagia| High cervical           | Endoscopic  |                    |                    |               | Remission  |
| n.a Male            | Odynophagia| High cervical         | Endoscopic  |                    |                    |               | Remission  |
| n.a Female          | Odynophagia| High cervical         | Endoscopic  |                    |                    |               | Remission  |
| n.a Female          | Odynophagia| High cervical         | Endoscopic  |                    |                    |               | Remission  |
| Sanroman-Alvarez et al., 2020\cite{35} | 53 Female | Dysphagia, dysphonia, dyspnea | C1- C2 | X-ray, CT | Endoscopic |                   | Remission  |

BSS - Barium Swallow Study, CT - Computed tomography, n.a. - Not available

### Table 5: Surgical approaches to C1-C2 anterior cervical osteophytes

| Surgical approach       | Advantages                                      | Disadvantages                                | Indication                              |
|-------------------------|-------------------------------------------------|----------------------------------------------|-----------------------------------------|
| Extended endoscopic     | Wide working area                               | Contaminated surgical field                  | Osteophytes limited to C1 (exceptional) |
| endonasal               | Good exposure of C1 and odontoid process        | Too downward oblique trajectory              |                                         |
|                         | Top-down drilling of the osteophyte             | Difficult C2 exposure (or below)             |                                         |
|                         | Less retraction                                 |                                              |                                         |
| Transoral               | Direct approach to the osteophyte               | Contaminated surgical field                  | C1-C2 osteophytes with no or limited C3 extension |
|                         | Good cranial and caudal exposure                | Not possible for mouth opening <3 cm         |                                         |
|                         | Top-down drilling                               | Tongue retraction and palate splitting       |                                         |
|                         |                                                  | More difficult if the osteophyte extends to C3 |                                         |
| Endoscopic transcervical| Sterile surgical field                          | Narrow working angle                         | C2 osteophytes with downward extension |
|                         | No pharyngeal opening                           | Difficult approach to large osteophytes      |                                         |
|                         | Less retraction                                 | Long working distance                        |                                         |
|                         | Good exposure up to C2                          | Pharyngeal retraction                        |                                         |
|                         |                                                  | Caudal to cranial resection alone            |                                         |
|                         |                                                  | No control of the superior osteophyte angle  |                                         |
we think that the microsurgical technique allows a good view in almost all cases.\cite{88}

The C3 vertebral osteophytes may be approached by both antero-lateral transcervical and transoral routes. In our experience, the antero-lateral cervical approach allows to well expose and resect the osteophyte, thus avoiding the transoral approach. Multilevel osteophytes extending above and below C3 may be approached by a combined transoral and antero-lateral approach in one-stage or two-stage operation, as in the case of our series.

**Endoscopic transcervical approach**

The endoscopic transcervical approach to the craniovertebral junction, proposed by Wolinsky et al.,\cite{89} is realized through minimally invasive tubular retractors with endoscopically controlled dissection. The advantages of this technique include the sterile surgical field, the lesser retraction with lower related complications [Table 5]. However, the working angle is narrow and the working distance is long [Figure 5]. Besides, this approach allows bone resection only in caudal to cranial direction, differently from the transoral approach, which also permits a superior to the inferior trajectory.

The transcervical endoscopic approach was first described for odontoid resection. On the other hand, we did not find reported cases of anterior osteophytes treated by this technique.

Although this approach may be useful for pathologies located from C4 to the inferior clivus, its optimal surgical trajectory is for lesions at or below C2; on the other hand, this approach is not recommended for access to the inferior clivus and C1. Because the transcervical approach is performed through dissection between the spine and the pharyngeal-esophagus complex, the large anterior osteophytes hinder this dissection. Although the osteophyte may be resected by drilling in a caudal to cranial dissection, its dome and superior angle are not controlled [Table 5].

**Endoscopic endonasal approach**

The endoscopic endonasal approach allows to well expose the craniovertebral junction, C1 and odontoid process\cite{90,91} [Figure 5], as shown by several anatomic studies from our neurosurgical group.\cite{92,93} Some conventional radiological lines, such as the nasopalatine\cite{94} and nasoaxial\cite{95} lines, have defined the inferior limit of the approach at the dens or at the upper half of the C2 body. Because of its limited downward extension and the oblique surgical view, the endoscopic endonasal approach is limited to C1, whereas the exposure of C2 is rather difficult. Besides, in the presence of an anterior osteophyte, the approach requires a more downward oblique trajectory to expose the dome of the osteophyte [Table 5]. For these reasons, we did not find cases of high cervical anterior osteophyte treated by this approach. We agree that the transoral approach provides a more direct surgical view to C1-C2 anterior osteophytes than the endoscopic endonasal approach.\cite{85,88,96,97}

Although the transoral approach carries the risk of infection from the oral flora, the rate of infection of transoral surgery is low with prophylactic antibiotics, ranging from 0.6% to 4%.\cite{86,98,99} A patient of our series presented pharyngeal flogosis extended to the prevertebral tissues and thrombosis of the right jugular vein and sigmoid-transverse sinuses. The inflammatory process, defined as “Lemierre’s syndrome,” is observed mainly as consequence of otolaryngological and pharyngeal infections,\cite{8,9,100} but it has not previously reported as a complication of transoral surgery.

**CONCLUSION**

The transoral approach is the best surgical route to resect C1 and C2 ACOs; on the other hand, the endoscopic endonasal approach is not indicated. Although osteophytes located at the C3 vertebral body may also be approached by the transoral route, the anterior transcervical approach is easier, as for those located from C3 to C7. A combined transoral and anterior transcervical approach may be necessary for multilevel osteophytes.

**Financial support and sponsorship**

Nil.

**Conflicts of interest**

There are no conflicts of interest.
REFERENCES

1. Akbal A, Kurtaran A, Selcuk B, Gurcan A, Ersoz M, Akyuz M. The development of dysphagia and dysphonia due to anterior cervical osteophytes. Rheumatol Int 2009;29:331-4.

2. Gamache FW Jr., Voorhies RM. Hypertrophic cervical osteophytes causing dysphagia. A review. J Neurol Surg 1980;53:338-44.

3. Seidler TO, Pérez Alvarez JC, Wonneberger K, Hacki T. Dysphagia caused by ventral osteophytes of the cervical spine: clinical and radiographic findings. Eur Arch Otorhinolaryngol 2009;266:285-91.

4. Granville LJ, Musson N, Altman R, Silverman M. Anterior cervical osteophytes as a cause of pharyngeal stage dysphagia. J Am Geriatr Soc 1998;46:1003-7.

5. Strasser G, Schima W, Schober E, Pokiezer P, Kaiden A, Denk DM. Cervical osteophytes impinging on the pharynx: importance of size and concurrent disorders for development of aspiration. AJR Am J Roentgenol 2000;174:449-53.

6. Resnick D, Niwayama G. Radiographic and pathologic features of spinal involvement in diffuse idiopathic skeletal hyperostosis (DISH). Radiology 1976;119:559-68.

7. Salassa JR. A functional outcome swelling scale for staging oropharyngeal dysphagia. Dig Dis 1999;17:230-4.

8. Hong P, Mac Cormick J, Lamothe A, Corsten M. Lemierre syndrome: Presentation of three cases. J Otolaryngol 2005;34:352-8.

9. Shimada M, Morinaga Y, Kitazaki T, Fukuoda M, Hashiguchi K, Yanagihara K, et al. A severe case of lemiere syndrome with streptococcus. Jpn J Infect Dis 2013;67:488-9.

10. Mariniello G, Briganti F, De Caro MLDB, Maiuri F. Cervical extradural En-plaque meningioma. J Neurological Surgery, Part A: Central European Neurosur 2012;73:330-3.

11. Di Vito Jr. Cervical osteophytic dysphagia: Single and combined mechanisms. Dysphagia 1998;13:58-61.

12. Marks B, Schober E, Swoboda H. Diffuse idiopathic skeletal hyperostosis causing obstructing laryngeal edema. Eur Arch Otorhinolaryngol 1998;255:256-8.

13. Kos MP, van Royen BJ, David EF, Mahieu HF. Anterior cervical osteophytes resulting in severe dysphagia and aspiration: Two case reports and literature review. J Laryngol Otol. 2009;123:1169-73.

14. Lambert JR, Pepperman PS, Jimenez J, Newman A. Cervical spine disease and dysphagia. Four new cases and a review of the literature. Am J Gastroenterol 1981;76:35-40.

15. Greg Brandenberg BS, Lyal G, Leibrock MD. Dysphagia and dysphonia secondary to anterior cervical osteophytes. Neurosurgery 1986;18:90-3.

16. Verlaan JJ, Boswijk PF, de Ru JA, Dbers WJ, Oner FC. OnerDiffuse idiopathic skeletal hyperostosis of the cervical spine: An underestimated cause of dysphagia and airway obstruction. Spine J 2011;11:1058-67.

17. McCafferty RR, Harrison MJ, Tams LS, Larkins MV. Ossification of the anterior longitudinal ligament and Forester’s disease: An analysis of seven cases. J Neurosurg 1995;83:13-7.

18. Valadka AB, Kabul WS, Smith MM. Updated management strategy for patients with cervical osteophytic dysphagia. Dysphagia 1995;10:167-71.

19. Demuyck K, van Calenbergh F, Goffin J, Verschakelen J, Demedts M, van de Woestijne K. Upper airway obstruction caused by a cervical osteophyte. Chest 1995;108:283-4.

20. Ramadas S, Muthubabu K, Hegde SK. Giant cervical osteophytes their significance in ENT practice. Indian J Otolaryngol Head Neck Surg 1997;49:394-8.

21. Riviere M, Forester disease disclosed by dysphagia. Apropos of a case. Neurochirurgie 1997;43:169-72.

22. Epstein NE, Hollingsworth R. Ossification of the cervical anterior longitudinal ligament contributing to dysphagia. Case report. J Neurosurg 1999;90:261-3.

23. Goel R, Sampath P, Mikaclian DO. Dysphagia caused by cervical osteophytes: three cases treated successfully by surgery. Otalaryngol Head Neck Surg 1999;120:92-6.

24. Motsch C, Grasshoff H, Freigang B. Anterior hyperostosis of the cervical spine: diagnostic studies and surgical therapy. Laryngorhinootologie 1999;78:150-4.

25. Akhtar S, O’Flynn PE, Kelly A, Valentine PM. The management of dysphagia in skeletal hyperostosis. J Laryngol Otol 2000;114:154-7.

26. Matar AI, Hsu J, Fredrickson BA. Management of respiratory compromise caused by cervical osteophytes: A case report and review of the literature. Spine J 2002;2:456-9.

27. Ido K, Hashitani M, Sakamoto A, Unushidani H. Surgical treatment for dysphagia caused by cervical hyperostosis: A report of three cases. J Orthopaed Traumatol 2002;3:55-8.

28. Giddings CE, Caulfield HM, Dorward NL. Diffuse idiopathic skeletal hyperostosis resulting in dysphagia and aspiration pneumonia. Br J Neurosurg 2003;17:467-8.

29. Fueterer S, Eysel-Gosepath K, Schröder U, Delank KS, Eysel P. Retro-pharyngeal obstruction in association with osteophytes of the cervical spine. J Bone Joint Surg Br 2004;86:837-40.

30. Mizuno J, Nakagawa H, Song J. Symptomatic ossification of the anterior longitudinal ligament with stenosis of the cervical spine: A report of seven cases. J Bone Joint Surg Br 2005;87:1375-9.

31. Calisanelle T, Ozdemir O, Tosun E, Altinors N. Dysphagia due to diffuse idiopathic skeletal hyperostosis. Acta Neurochir (Wien) 2005;147:1203-6.

32. Galiano K, Gotwald T, Maier H, Schatzer R, Obwegeser A. Rapidly progressive dysphagia caused by Forester’s disease: A case report. Wien Klin Wochenschr 2005;117:234-6.

33. Ng J, Gnanalingham KK, Stokes O, Singh A, Casey A. Anterior cervico-thoracic osteophytes: An unusual cause of dysphagia. Br J Neurosurg 2005;19:173-4.

34. Castellano DM, Sinacori JT, Karakla DW. Stridor and dysphagia in diffuse idiopathic skeletal hyperostosis (DISH). Laryngoscope 2006;116:341-4.

35. Giger R, Duglerov P, Payer M. Anterior cervical osteophytes causing dysphagia and dyspnea: An uncommon entity revisited. Dysphagia 2006;21:259-63.

36. Di Martino A, Vincenzo C, Vincenzo D. Dysphagia and dysphonia due to anterior cervical osteophytes: Report of a patient affected by DISH. Eur J Orthop Surg Traumatol 2006;16:344-7.

37. Montinaro A, D’Agostino A, Punzi F, Cantisani PL. Cervical anterior hyperostosis: A rare cause of dysphagia. Report of 3 cases. J Neurosurg Sci 2006;50:75-7.

38. Nelson RS, Urquhart AC, Faciszewski T. Diffuse idiopathic skeletal hyperostosis: A rare cause of dysphagia, airway obstruction, and dysphonia. J Am Coll Surg 2006;202:938-42.

39. Song J, Mizuno J, Nakagawa H. Clinical and radiological analysis of ossification of the anterior longitudinal ligament causing dysphagia and hoarseness. Neurosurgery 2006;58:913-9.

40. Alcazar L, Jerez P, Gomez-Angulo JC, Tamarit M, Navarro R, Ortega JM, et al. Forester-rotas-querol’s disease. Ossification of the anterior longitudinal ligament as a cause of dysphagia (in Spanish) Neurocirugia (Astur) 2008;19:350-5.

41. Burdak PK, Wierzchowska M, Grzelalak L, Dalke K, Mierzwiński J. Anterior hyperostosis: A rare cause of dysphagia. Otolaryngol Pol 2008;62:138-40.

42. Caminos CB, Cenoz IZ, Louis CJ, Ottano TB, Easam BF, Pérez de Ciriza MT, Forestier disease: an unusual cause of upper airway obstruction. Am J Emerg Med 2008;26:1072.e1-3.

43. Constantyannis C, Papadas T, Konstantinou D. Diffuse idiopathic skeletal hyperostosis as a cause of progressive dysphagia: A case report. Cases J 2008;1:416.

44. De Jesus-Monge WE, Cruz-Cuevas EI. Dysphagia and lung aspiration secondary to anterior cervical osteophytes: A case report and review of the literature. Ethn Dis 2008;18:32-137-40.
Maiuri, et al.: Anterior cervical osteophytes causing dysphagia

45. Park E, Kang S, Rhim S, Roh SW, Jeon SR. Dysphagia caused by anterior cervical osteophytes: Different surgical outcomes in three cases. Korean J Spine 2008;5:207-10.

46. Solaroğlu I, Okutan O, Karakuş M, Saygili B, Beşkonakli E. Dysphagia due to diffuse idiopathic skeletal hyperostosis of the cervical spine. Turk Neurosurg 2008;18:409-11.

47. Krishnarasa B, Vivekanandanarajah A, Ripoll L, Chang E, Wetz R. Diffuse idiopathic skeletal hyperostosis (DISH) - a rare etiology of dysphagia. Clin Med Insights Arthritis Musculoskel Disord 2011;4:71-5.

48. Lin HW, Quesnel AM, Holman AS, Curry WT Jr., Rho MB. Hypertrophic anterior cervical osteophytes causing dysphagia and airway obstruction. Ann Otol Rhinol Laryngol 2009;118:703-7.

49. Miyamoto K, Sugiyama S, Hosoe H, Inuma N, Suzuki Y, Shimizu K. Posturgical recurrence of osteophytes causing dysphagia in patients with diffuse idiopathic skeletal hyperostosis. Eur Spine J 2009;18:1652-8.

50. Oppenlander ME, Orringer DA, LaMarca F, McGillicuddy JE, Sullivan SE, Chandler WF, et al. Dysphagia due to anterior cervical hyperostopatosis. Surg Neurol 2009;72:266-70.

51. Urrutia J, Bon CM. Long-term results of surgical treatment of dysphagia secondary to cervical diffuse idiopathic skeletal hyperostosis. Spine J 2009;9:e13-7.

52. Goh PY, Dobson M, Iseli T, Maartens NF. MaartensForestier’s disease presenting with dysphagia and dysphonia. J Clin Neurosci 2010;17:1336-8.

53. Lecerf P, Malard O. How to diagnose and treat symptomatic anterior cervical osteophytes? Eur Ann Otorhinolaryngol Head Neck Dis 2010;127:111-6.

54. Ozguroy OB, Salassa JR, Reimer R, Wharen RE, Deen HG. Anterior cervical osteophyte dysphagia: Manofluorographic and functional outcomes after surgery. Head Neck 2010;32:588-93.

55. Vengust R, Mihalic R, Turel M. Two different causes of acute respiratory failure in a patient with diffuse idiopathic skeletal hyperostosis and ankylosed cervical spine. Eur Spine J 2010;19:S130-4.

56. Carlson ML, Archibald DJ, Graner DE, Kasperbauer JL. Surgical management of dysphagia and airway obstruction in patients with prominent ventral cervical osteophytes. Dysphagia 2011;26:34-40.

57. Kapetanakis S, Vasileiadis I, Papanas N, Goulimari R, Maltezos E. Can a giant cervical osteophyte cause dysphagia and airway obstruction? A case report. Wien Klin Wochenschr 2011;123:291-3.

58. Fox TP, Desai MK, Cavenagh T, Mew E. Diffuse idiopathic skeletal hyperostosis: A rare cause of dysphagia and dysphonia. BMJ Case Rep 2013;2013. pii: bcr2013030987.

59. Hwang JS, Chough CK, Joo WI. Giant anterior cervical osteophyte leading to Dysphagia. Korean J Spine 2013;10:200-2.

60. Seo JW, Park JW, Jang JC, Kim JW, Lee YG, Kim YT, et al. Anterior cervical osteophytes causing Dysphagia and paradoxical vocal cord motion leading to dyspnea and dysphonia. Ann Rehabil Med 2013;37:177-20.

61. Bacigaluppi S, Merciadri P, Secchi F, Bragazzi NL, Zona G. An unusual cause of dysphagia: “DISHphagia”. Br J Neurosurg 2015;29:275-6.

62. von der Hoeh NH, Voelker A, Jarvers JS, Gulow J, Heyde CE. Results after the surgical treatment of anterior cervical hyperostosis causing Dysphagia. Eur Spine J 2015;24 Suppl 4:S489-93.

63. Jeong H, seo HG, Han TR, Chung CK, Oh BM. Kinematic changes in swallowing after surgical removal of anterior cervical osteophytes causing Dysphagia: A case series. Ann Rehabil Med 2014;38:865-70.

64. Zhang C, Ruan D, He Q, Wen T, Yang P. Progressive dysphagia and neck pain due to diffuse idiopathic skeletal hyperostosis of the cervical spine: A case report and literature review. Clin Interv Aging 2014;9:553-7.

65. Egerter AC, Kim ES, Lee DJ, Liu JJ, Cadena G, Panchal RR, et al. Dysphagia secondary to anterior osteophytes of the cervical spine. Glob Spine J 2015;5:e78-83.

66. Chen YR, Sung K, Tharin S. Symptomatic anterior cervical osteophyte causing dysphagia: Case report, imaging, and review of the literature. Cureus 2016;8:e473.

67. Vodíčar M, Košak R, Vengust R. Long-term results of surgical treatment for asymptomatic anterior cervical osteophytes: A case series with review of the literature. Clin Spine Surg 2016;29:E482-E487.

68. Allenworth JJ, O’Dell KD, Schindler JS. Bilateral vocal fold paralysis and dysphagia secondary to diffuse idiopathic skeletal hyperostosis. Head Neck 2017;39:E1-3.

69. Erdur O, Tastili H, Polat B, Sofiyev F, Tosun F, Colpan B, et al. Surgical management of dysphagia due to anterior cervical osteophytes. J Craniofac Surg 2017;28:e80-4.

70. Kkaaraslan N, Görbüz MS, Çalışkan T, Simsek AT. Forestier syndrome presenting with dysphagia: Case report of a rare presentation. J Spine Surg 2017;3:723-6.

71. Alsalmi S, Bugdadi A, Alkhayri A, Fichten A, Peltier J. Urgent anterior cervical osteophyectomy for an asymptomatic cervical hyperostosis to overcome failed intubation. Cureus 2018;10:e2400.

72. Hongo M, Miyakoshi N, Fujii M, Kasukawa Y, Ishikawa Y, Kudo D, et al. Pyogenic spondylitis caused by methicillin-resistant staphylococcus aureus associated with tracheostomy followed by resection of ossification of the anterior longitudinal ligament. Case Rep Orthop 2018;2018:5.

73. Lui Jonathan YC, Sayal P, Prezerakos G, Russo V, Choi D, Casey AT. The surgical management of dysphagia secondary to diffuse idiopathic skeletal hyperostosis. Clin Neurol Neurosurg 2018;167:36-42.

74. Psychogios G, Jering M, Zenz K. Cervical hyperostosis leading to dyspnea, aspiration and dysphagia: Strategies to improve patient management. Front Surg 2018;5:33.

75. Sebaaly A, Boubez G, Sunna T, Wang Z, Alam E, Christopoulos A, et al. diffuse idiopathic hyperostosis manifesting as dysphagia and bilateral cord paralysis: A case report and literature review. World Neurosurg 2018;111:79-85.

76. Yoshioka K, Murakami H, Demura S, Kato S, Yonezawa N, Takahashi N, et al. Surgical treatment for cervical diffuse idiopathic skeletal hyperostosis as a cause of dysphagia. Spine Surg Relat Res 2018;2:197-201.

77. Ruetten S, Baraliakos X, Godolias G, Komp M. Surgical treatment of anterior cervical osteophytes causing dysphagia. J Orthop Surg (Hong Kong) 2019;27. doi: 2309499019837424.

78. Scholz C, Naseri Y, Hohenhaus M, Hubbe U, Klingler JH. Long-term results after surgical treatment of diffuse idiopathic skeletal hyperostosis (DISH) causing dysphagia. J Clin Neurosci 2019;67:151-5.

79. Soejima Y, Arima J, Doi T. Diffuse idiopathic hyperostosis: A case with dysphagia, dysphonia and myelopathy. Am J Case Rep 2019;20:349-53.

80. Damade C, Masse R, Ghaliane S, Petit M, Castelain JE, Gille O, et al. Anterior cervical idiopathic hyperostosis and dysphagia: The impact of surgical management-study of a series of 11 cases. World Neurosurg 2020;138:e505-10.

81. Jabarkheel R, Chen YR, Xu L, Yan CH, Patel ZM, Desai AM. Transoral endoscopic resection of high cervical osteophytes with long-term symptom resolution: Case series: imaging, and literature review. World Neurosurg 2018;120:240-3.

82. Hsu W, Wolinsky JP, Gokaslan ZL, Sciubba DM. Transoral approaches to the cervical spine. Neurosurgery 2010;66:119-25.

83. Sanromán-Alvarez P, González-Vargas P, Rodríguez-Fernández JL, De la Lama-Zaragoza A. Fully endoscopic transoral resection of high cervical osteophyte: How I do it? Acta Neurochir (Wien) 2020;162:131-4.

84. Perrini P, Benedetto N, Guidi E, Di Lorenzo N. Transoral approach and its superior extensions to the craniovertebral junction malformations: Surgical strategies and results. Neurosurgery 2009;64:331-42.

85. Visocchi M, Signorelli F, Liao C, Rigante M, Ciappetta P, Barbagallo G, et al. Transoral versus transnasal approach for craniovertebral junction pathologies: Which route is better? Acta Neurochir Suppl 2019;125:181-6.

86. Choi D, Crockard HA. Evolution of transoral surgery: Three decades of change in patients, pathologies, and indications. Neurosurgery 2013;73:296-303.
87. Baird CJ, Conway JE, Sciuabba DM, Prevedello DM, Quiñones-Hinojosa A, Kassam AB. Radiographic and anatomic basis of endoscopic anterior craniocervical decompression: A comparison of endonasal, transoral, and transcervical approaches. Neurosurgery 2009;65:158-63.

88. Pillai P, Baig MN, Karas CS, Ammirati M. Endoscopic image-guided transoral approach to the craniovertebral junction: an anatomic study comparing surgical exposure and surgical freedom obtained with the endoscope and the operating microscope. Neurosurgery 2009;64:437-42.

89. Wolinsky JP, Sciuabba DM, Suk I, Gokaslan ZL. Endoscopic image-guided odontoidectomy for decompression of basilar invagination via a standard anterior cervical approach. Technical note. J Neurosurg Spine 2007;6:184-91.

90. Kassam AB, Snyderman C, Gardner P, Carrau R, Spiro R. The expanded endonasal approach: A fully endoscopic transnasal approach and resection of the odontoid process: technical case report. Neurosurgery 2005;57:E213.

91. Visocchi M, Signorelli F, Liao C, Rigante M, Paludetti G, Barbagallo G, et al. Endoscopic endonasal approach for craniovertebral junction pathologic conditions: Myth and truth in clinical series and personal experience. World Neurosurg 2017;101:122-9.

92. Cavallo LM, Cappabianca P, Messina A, Esposito F, Stella L, de Divitiis E, et al. The extended endoscopic endonasal approach to the clivus and cranio-vertebral junction: Anatomical study. Childs Nerv Syst 2007;23:665-71.

93. Messina A, Bruno MC, Decq P, Coste A, Cavallo LM, de Divitiis E, et al. Pure endoscopic endonasal odontoidectomy: anatomical study. Neurosurg Rev 2007;30:189-94.

94. de Almeida JR, Zanation AM, Snyderman CH, Carrau RL, Prevedello DM, Gardner PA, et al. Defining the nasopalatine line: The limit for endonasal surgery of the spine. Laryngoscope 2009;119:239-44.

95. Aldana PR, Naseri I, La Corte E. The naso-axial line: A new method of accurately predicting the inferior limit of the endoscopic endonasal approach to the craniovertebral junction. Neurosurgery 2012;71:ons308-14.

96. Seker A, Inoue K, Osawa S, Akakin A, Kilic T, Rhoton AL Jr. Comparison of endoscopic transnasal and transoral approaches to the craniovertebral junction. World Neurosurg 2010;74:583-602.

97. Visocchi M, Germano’ A, Umana G, Richiello A, Raudino G, Eldella AM, et al. Direct and oblique approaches to the craniovertebral junction: Nuances of microsurgical and endoscope-assisted techniques along with a review of the literature. Acta Neurochir Suppl 2017;124:107-16.

98. Shousha M, Mosafer A, Boehn H. Infection rate after transoral approach for the upper cervical spine. Spine (Phila Pa 1976) 2014;39:1578-83.

99. Yin Q, Xia H, Wu Z, Ma X, Ai F, Zhang K, et al. Surgical site infections following the transoral approach: A review of 172 consecutive cases. Clin Spine Surg 2016;29:E502-8.

100. Johannesen KM, Bodgier U. Lemierre’s syndrome: Current perspectives on diagnosis and management. Infect Drug Resist 2016;9:221-7.