



Available online at  
**ScienceDirect**  
[www.sciencedirect.com](http://www.sciencedirect.com)

Elsevier Masson France  
**EM|consulte**  
[www.em-consulte.com/en](http://www.em-consulte.com/en)



Original article

## Spondylodiscitis after transoral robotic surgery: Retrospective 7-case series from the GETTEC group



C. Carpentier<sup>a</sup>, C. Bobillier<sup>a</sup>, D. Blanchard<sup>b</sup>, B. Lallemand<sup>c</sup>, R. Garrel<sup>d</sup>, P. Gorphe<sup>e</sup>,  
 R. Mastronicola<sup>f</sup>, S. Morinière<sup>a,\*</sup>

<sup>a</sup> Service d'ORL et chirurgie cervico-faciale, CHU Bretonneau, 2, boulevard Tonnellé, 37000 Tours, France

<sup>b</sup> Service d'ORL et chirurgie cervico-faciale, centre François-Baclesse, 3, avenue du Général-Harris, 14000 Caen, France

<sup>c</sup> Service d'ORL et chirurgie cervico-faciale, CHU Carêmeau, place du Pr.-Robert-Debré, 30029 Nîmes cedex 9, France

<sup>d</sup> Service d'ORL et chirurgie cervico-faciale, CHU Gui-de-Chauliac, 80, avenue Augustin-Fliche, 34090 Montpellier, France

<sup>e</sup> Service d'ORL et chirurgie cervico-faciale, Institut Gustave-Roussy, 114, rue Édouard-Vaillant, 94800 Villejuif, France

<sup>f</sup> Service d'ORL et chirurgie cervico-faciale, Institut de Cancérologie de Lorraine Alexis-Vautrin, 6, avenue de Bourgogne, 54500 Vandœuvre-lès-Nancy, France

### ARTICLE INFO

#### Keywords:

Cervical spondylodiscitis  
 TORS  
 Transoral robotic surgery  
 Pharyngeal tumor  
 Spondylodiscitis  
 Robotic surgery

### ABSTRACT

**Background:** Cervical spondylodiscitis is a rare but severe complication of pharyngeal surgery.

**Material and methods:** This multicenter retrospective study reported all patients in the database of the French head and neck tumor study group (GETTEC) affected by cervical spondylodiscitis after transoral robotic surgery (TORS) for malignant pharyngeal tumor from January 2010 to January 2017.

**Objectives:** To describe cases of post-TORS cervical spondylodiscitis, identify alarm signs, and determine optimal management of these potentially lethal complications.

**Results:** Seven patients from 6 centers were included. Carcinomas were located in the posterior pharyngeal wall. Tumor stage was T1 or T2. All patients had risk factors for spondylodiscitis. Mean time to diagnosis was 12.6 days. The interval between surgery and spondylodiscitis diagnosis ranged from 20 days to 4.5 months, for a mean 2.1 months. The most common symptom was neck pain (87%). Infections were polymicrobial; micro-organisms were isolated in 5 cases and managed by intravenous antibiotics, associated to medullary decompression surgery in 3 cases. Follow-up found favorable progression in 4 cases, and 3 deaths (mortality, 43%).

**Conclusion:** This French multicenter study found elevated mortality in post-TORS spondylodiscitis, even in case of limited resection. Surgeons must be aware of this complication and alerted by persistent neck pain, fever, asthenia, impaired or delayed posterior pharyngeal wall wound healing or elevation of inflammatory markers. MRI is the most effective diagnostic radiological examination.

© 2019 Elsevier Masson SAS. All rights reserved.

### 1. Introduction

Since the first publication by Haus et al. in 2003, transoral robotic surgery (TORS) has been widely developed [1,2]. In 2009, the US Food and Drug Administration (FDA) approved TORS for resection of stage T1 and T2 malignant tumors and benign tumors of the oropharynx, larynx and hypopharynx. Efficacy and 2- and 3-year overall and local recurrence-free survival are non-inferior to open surgery and chemoradiotherapy [3–5]. Rates of postoperative tracheotomy and gastrostomy and hospital stay are lower than for open surgery [6,7]. The most frequent post-TORS complications are

hemorrhage (2.4–3.1%), pharyngostoma (2.5%), surgery site infection (2.3%), and pneumopathy (0–7%) [8,9].

To our knowledge, no case series of post-TORS spondylodiscitis have been reported, although this complication is well-known in open pharyngeal surgery, and risk factors have been identified [10,11]. Cases have been reported following neopharyngeal surgery after total circumferential pharyngolaryngectomy, voice prosthesis implantation, and velopharyngeal flap grafting [12–15]. It is a severe, sometimes lethal complication. Morbidity and mortality are higher than in other sites [10,11], partly due to difficult and often late diagnosis [16].

Several cases of cervical spondylodiscitis were reported the French head and neck tumor study group (GETTEC) following TORS for malignant pharyngeal tumor. The objectives of the present study were to describe clinical symptomatology, treatment and

\* Corresponding author.

E-mail address: [sylvain.moriniere@univ-tours.fr](mailto:sylvain.moriniere@univ-tours.fr) (S. Morinière).

progression in these cases and determine optimal management and alarm signs.

## 2. Material and method

A multicenter retrospective study conducted by the GETTEC included all cases of cervical spondylodiscitis following TORS for malignant pharyngeal tumor, between January 2010 and January 2017.

GETTEC surgeons were requested by e-mail to collate study variables for all cases of spondylodiscitis. Inclusion criteria comprised radiologic criteria for spondylodiscitis with microbiology data for infection and/or non-specific inflammation on histologic analysis of discovertebral biopsy. The radiology criteria were those of the French Infectious Diseases Society (SPILF): i.e., suggestive CT or MRI images, such as pincer-type disc lesion or change in signal density, with possible osteolytic vertebral body involvement or paravertebral infiltration.

Data for age, gender, history of pharyngolaryngeal cancer and treatments, risk factors for spondylodiscitis (history of cervical radiation therapy, malnutrition or overweight according to body-mass index (BMI), corticosteroid therapy, diabetes, kidney failure, HIV infection, drug addiction, coronaropathy, smoking, alcohol dependency) were collected. The tumor was staged according to the 7th version of the TNM classification, associating adjuvant or neoadjuvant treatments. Spondylodiscitis variables comprised clinical signs, time to diagnosis, diagnosis-to-TORS interval, presence of inflammatory syndrome (CRP >5 mg/L, leukocytes >10,000/L), bacteria isolated from samples, histologic analysis of biopsies, MRI and CT reports, antibiotic therapy, surgical procedures, use of cervical contention, and clinical neurological sequelae. Choice of antibiotic therapy was multidisciplinary, with systematic infectology opinion; administration was parenteral, with oral relay.

## 3. Results

The GETTEC robotic surgery group comprised 13 centers at the time of the study, with 1084 robotic procedures between January 2010 and January 2017.

Seven patients, from 6 centers, were included: 5 male, 2 female, aged 54–69 years at diagnosis. Table 1 shows pharyngolaryngeal oncologic history and treatments. Four had had cervical radiation therapy prior to TORS, including 2 with chemoradiotherapy.

All showed risk factors for spondylodiscitis (Table 1). Four showed 1 risk factor: cervical radiation therapy in 3 cases, and overweight in 1. Two showed 2 risk factors: alcohol dependency and active smoking. One showed 3 risk factors: kidney failure and coronaropathy with history of cervical radiation therapy.

All were operated on by TORS for T1 ( $n=3$ ) or T2 ( $n=4$ ) malignant pharyngeal tumor, systematically located in the posterior pharyngeal wall, with lateral wall extension in 2 cases. Hypopharyngeal and oropharyngeal locations had equal incidence (both 43%). In 1 case, the tumor was at the oropharyngeal-hypopharyngeal junction. In 4 cases, resection included the superior pharyngeal constrictor muscle, sparing the prevertebral fascia; prevertebral fascia conservation was not specified in the other 3 cases. Dissection was systematically monopolar. In 2 cases, the resection site was filled using TISSUCOL KIT<sup>®</sup> and mucosal sutures. In 1 case, an anterolateral thigh free flap was used. Ipsilateral neck dissection was associated in the same step in 3 cases, only 1 of which showed lymph-node involvement. Two sentinel node procedures were performed, with negative histology in both.

Adjuvant chemoradiotherapy was implemented in 1 case, for non-resectable metastatic vesical carcinoma.

The mean interval between diagnosis of spondylodiscitis and TORS was 2.1 months (range, 20 days to 4.5 months), for a median 2 months. Mean time from symptom onset to diagnosis was 12.6 days (range, 1 week to 1 month). Differential diagnoses considered were osteoradionecrosis or progressive relapse of pharyngeal cancer.

Neck pain was the main symptom reported by patients, in 6 of the 7 cases. There was associated neurologic deficit and fever in 57% of cases. In 3 cases, onset was during intensive care for cardiorespiratory arrest. Table 2 shows the symptomatology revealing spondylodiscitis.

Table 3 shows biological and imaging findings. Biological abnormalities comprised biological inflammatory syndrome in 3 cases. Three patients showed CRP elevation without hyperleukocytosis; 1 showed hyperleukocytosis, with no CRP assessment. Bacteriology used blood culture in 1 case, intraoperative biopsy in 5, and fine needle aspiration under CT in 1. Bacteria were identified in 5 cases, and were multiple in patient 2 (*Streptococcus milleri*, *Peptoniphilus* spp, *Eikenella corrodens*, Gram-negative bacilli, anaerobic bacteria, and *Gemella morbillorum*) and patient 6 (methicillin-susceptible *Escherichia coli*, *Candida glabrata*, *Candida albicans*); the other 3 cases implicated a single strain: *Streptococcus constellatus* in patients 3 and 4, and *Citrobacter koseri* in patient 5. In patients 1 and 7, biopsy indicated non-specific inflammation, ruling out recurrence of carcinoma.

Pathologic radiology images comprised vertebral body lysis (Fig. 1 A) in 5 patients, vertebral body contrast uptake (Fig. 1 B) in 4, medullary compression in 4, and epiduritis in 5 (4 abscesses and 1 pharyngodural fistula). The most frequent location was C3–C4 (71%), isolated in 3 cases, and with multiple level involvement in 2 (patient 1: C2–C5; patient 7: C2–C4); the other 2 cases concerned C4–C5 and C2–C3.

Various adapted long-course antibiotic regimes, with good bone penetration, were administered; in 2 cases, samples were negative and wide spectrum antibiotic therapy was used.

Cervical contention was used in 2 cases. Five patients underwent medullary decompression or pharyngeal surgery site debridement with biopsy.

Two patients had follow-up MRI at 1 year, with no residual spondylodiscitis. Three patients showed favorable progression without neurologic sequelae. One patient had motor deficit with ataxia requiring use of a walking cane. There was 1 death at 1 year, from metastatic lung cancer, and 3 deaths during follow-up due to progression of spondylodiscitis.

## 4. Discussion

The present multicenter study included all 7 cases of post-TORS spondylodiscitis managed within the GETTEC group. The total number of tumors with posterior pharyngeal wall involvement treated by TORS within the GETTEC group was not available. A recent GETTEC study reporting good 2-year functional and oncologic results with TORS in pT1 posterior pharyngeal wall tumor included 2 of the present cases [17].

In the present study, 3 of the 7 patients died from their spondylodiscitis, which is more than the 4–29% rates reported elsewhere, perhaps due to the cervical location and multiple comorbidity in the present series, and to poor specificity of symptoms, delaying and complicating diagnosis [10,16].

Mean time to diagnosis after symptom onset in the literature ranges between 2 and 6 months [18]; it was shorter in the present study (12.6 days), but this was partly due to the rapid deterioration seen in 3 of the 7 cases. The time to onset after spinal surgery ranges between 1 and 4 weeks in the literature [17], but was longer (mean, 2.1 months) in the present series, due to difference in inoculation

**Table 1**  
Medical and surgical history of the 7 post-TORS spondylodiscitis patients.

Case	1	2	3	4	5	6	7	Mean
Gender	F	F	M	M	M	M	M	M: 71%F: 29%
Age (years)	54	61	59	62	68	75	57	62.3
BMI (kg/m <sup>2</sup> )	20.56	25.9	18.44	24.5	24.33	21	24	23.0
Smoking	Ceased for 9 years	–	40 P/Y Current	50 P/Y Current	Ceased	Ceased, after 40 P/Y	Ceased for 9 years	29%
Alcohol	Ceased for 1 year	–	+	+	Ceased	–	–	29%
Kidney failure	–	–	–	–	–	+	–	14%
Coronaropathy	–	–	–	–	–	+	–	14%
ENT oncologic history	CRT + Surgery	0	0	0	Bilateral RT + Surgery	RT + Surgery	CRT + Surgery	57%

BMI: body-mass index; P/Y: Pack/years; RT: radiation therapy; CRT: chemoradiotherapy.

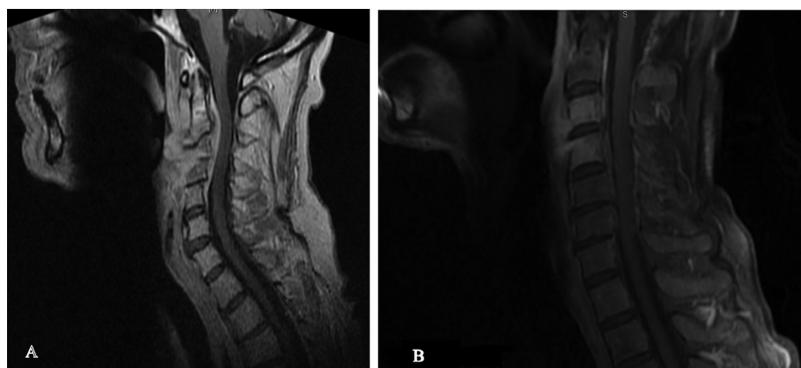
**Table 2**  
Clinical signs of cervical spondylodiscitis following TORS (n = 7).

Symptoms	Case 1	Case 2	Case 3	Case 4	Case 5	Case 6	Case 7	Mean
Fever	–	–	+	+	–	+	+	57%
Neck pain	+	+	+	+	+	–	+	86%
Healing defect	+	–	–	–	+	–	+	43%
Difficulty in resuming feeding	+	–	–	–	+	–	+	43%
Neurologic deficit	–	+	–	+	+	+	–	57%
Confusion	–	–	–	+	+	–	–	29%
Time to onset	2 months	1 month	1 month	4.5 months	D20	2 months	3.5 months	2.1 months

**Table 3**  
Biology and radiology results in cervical spondylodiscitis (n = 7).

Examination	Case 1	Case 2	Case 3	Case 4	Case 5	Case 6	Case 7	%
CRP > 5 mg/L	+	+	+	+	+	ND	+	86
Hyperleukocytosis > 10 G/L	–	+	+	–	+	+	–	57
Bacteriology/mycology	–	Polybacterial	<i>Streptococcus constellatus</i>	<i>Streptococcus constellatus</i>	<i>Citrobacter Koseri</i>	<i>Escherichia coli</i> , <i>Candida glabrata</i> and <i>albicans</i>	–	
MRI/CT								
Soft-tissue inflammation	+	–	+	+	–	–	+	57
Vertebral body contrast uptake	+	–	+	–	+	–	+	57
Bone lysis	+	–	+	+	–	+	+	71
Medullary compression	+	+	–	+	+	–	–	57
Epidural abscess	–	+	–	+	+	–	–	43
Epiduritis	+	+	+	+	+	–	–	71
Pharyngodural fistula	–	–	–	–	+	–	+	29
Pharyngeal abscess	–	–	–	–	–	+	–	14

ND: no data.

**Fig. 1.** MRI aspect of post-TORS cervical spondylodiscitis. A. Case no. 1: gadolinium-enhanced T1-weighted MRI. Aspect of spondylodiscitis with C3–C4 vertebral body bone lysis: C3–C4 hyposignal enhanced by contrast medium, with medullary canal compression. B. Case no. 3: gadolinium-enhanced T1-weighted MRI. C3–C4 spondylodiscitis: C3–C4 vertebral body contrast uptake and prevertebral soft-tissue infiltration.

mechanism, which is probably by contiguity following TORS but direct in spinal surgery.

Neck pain, the prime symptom, is a sensitive but relatively non-specific sign, frequently found following pharyngeal surgery, and often isolated [14]. In the present series, 6 of the 7 patients (86%) had neck pain, which is in line with the literature (67–100%) [10]. Neck pain in the present series differed from normal postoperative pain: it was hyperintense, with onset after a free interval of several days or weeks. Fever and neurologic deficit were also found in 57% of cases, in line with the literature [18].

Risk factors for spondylodiscitis were found in all patients. Five had pre- or post-operative cervical radiation therapy [15]. In the literature, the percentage of spondylodiscitis patients showing risk factors ranges between 2 and 79% [14]. Risk of oropharyngeal carcinoma and of spondylodiscitis concerns the same population: elderly and male subjects [10,19]. Some of the risk factors for postoperative spondylodiscitis identified by Nickerson (long operative time, severe blood loss, tissue irradiation, extensive soft-tissue dissection, tissue necrosis, creation of a dead space) were found in the present series: 5 patients with local radiation treatment, and 1 with dissection extending to the whole posterior pharyngeal wall [10]. TORS is frequently associated to adjuvant radiation therapy (60%). When delivered to treat a posterior pharyngeal wall tumor, this considerably increases the risk of spondylodiscitis, due to tissue necrosis and consequent superinfection [20,21]. Unlike in open surgery, TORS consists in monopolar dissection, and reconstruction is less common. In posterior pharyngeal wall resection by TORS without reconstruction, the cervical spine is close to a possible infection entry point, and secondary cervical spondylodiscitis may arise by contiguity. To reduce this risk, the prevertebral fascia should be conserved, respecting the TORS dissection plane described in the literature [22]. Flap reconstruction should be considered, especially in case of spondylodiscitis risk factors and/or dissection extending to the whole posterior wall. In 2 of the present patients, the TISSUCOL KIT<sup>®</sup> was used, with mucosal sutures, but this proved insufficient. The case of free flap reconstruction also did not prevent onset of spondylodiscitis: a pharyngeal fistula occurred at the junction between the pharyngeal mucosa and the skin paddle of the flap at 3 months, despite initially good progression.

Low intensity monopolar dissection could also reduce the risk of tissue necrosis. The FDA reported burn complications associated with monopolar dissection in robotic laparoscopic surgery, caused by electric arcs induced by contact with cold instruments or by defective insulation. One study reported a parasitic current within robotic laparoscopic instruments, liable to cause burning [21]. These factors call for care in monopolar dissection of the posterior pharyngeal wall.

CRP was elevated whenever assayed, in line with the literature [18]. Absence of inflammatory syndrome, however, does not rule out spondylodiscitis. Rather, postoperatively, inflammatory syndrome is harder to interpret, as sensitivity is lower [18]. The SPILF monitoring protocol recommends weekly CRP assay for the first 2 weeks then every 2 weeks until normalization.

Staphylococcus aureus is the bacterium most often implicated in spondylodiscitis [10], but was isolated in none of the present patients. Isolates differed from patient to patient, except for Streptococcus, which was found in 3 cases, probably due to the pharyngeal entry. Blood culture is less often positive (14%) when spondylodiscitis is secondary to surgery [18], and should be repeated even in absence of fever. In case of negative culture, fine needle aspiration should be performed under CT control as soon as possible, for bacteriology and histology. Biopsy should be followed by 2 or 3 blood cultures within 4 hours [18,23]. In case of negative culture, the composition and time to initiation of antibiotic therapy will depend on the clinical context and degree of urgency [23].

Sagittal and axial slice MRI, in T1 and T2 sequences and with gadolinium injection, is the recommended first-line radiology examination. Sensitivity is 93–96% and specificity 92.5–97%, enabling early diagnosis, screening for complications (epidural abscess, medullary compression) and providing evidence for or against differential diagnosis of neoplasia [18]. Complete medullary MRI should be prescribed, to screen for synchronous asymptomatic infection sites, within 48–72 hours. In case of abnormality on MRI, examination should be repeated 1 or 2 weeks later. Bone scan, with 94% sensitivity, may be used in second line, or CT with contrast enhancement in case of contraindications to or unavailability of MRI [18,23]. According to the SPILF protocol, radiologic monitoring consists in plain spinal X-ray. Follow-up MRI is not recommended in case of favorable progression.

Three of the present series required drainage or decompression. This procedure should be performed in emergency in case of onset of signs of radicular deficit, sensorimotor deficit or paralysis with less than 72 hours' progression; later, the chances of recovery are poorer. Epidural abscess should only be drained if associated with clinical signs of compression. Stabilization surgery is recommended in case of major deformity. A Minerva brace is recommended in cervical spondylodiscitis [23]; in the present series, only 2 patients had cervical contention.

## 5. Conclusion

In the present series, 3 of the 7 patients died due to spondylodiscitis. This rate could be reduced by earlier optimized treatment [18]. Patients with multiple comorbidities undergoing surgery for posterior pharyngeal wall tumor without reconstruction are at risk. Any atypical neck pain following TORS is suggestive of cervical spondylodiscitis. Diagnostic work-up comprises screening for biological inflammatory syndrome and contrast-enhanced MRI within 72 hours. Bacteriology should be early, on repeated blood culture, with CT-guided biopsy in case of negative findings. Antibiotic therapy should be adapted to the isolates, with good bone penetration, and associated to cervical contention.

## Disclosure of interest

The authors declare that they have no competing interest.

## References

- [1] Haus BM, Kambham N, Le D, Moll FM, Gourin C, Terris DJ. Surgical robotic applications in otolaryngology. *Laryngoscope* 2003;113:1139–44.
- [2] Dziegielewski PT, Kang SY, Ozer E. Transoral robotic surgery (TORS) for laryngeal and hypopharyngeal cancers. *J Surg Oncol* 2015;112:702–6.
- [3] de Almeida JR, Li R, Magnuson JS, Smith RV, Moore E, Lawson G, et al. Oncologic outcomes after transoral robotic surgery: a multi-institutional study. *Otolaryngol Head Neck Surg* 2015;141:1043–51.
- [4] Lőrincz BB, Möckelmann N, Busch C-J, Münscher A, Sehner S, Dalchow CV, et al. Two-year survival analysis of 50 consecutive head and neck cancer patients treated with transoral robotic surgery in a single European Centre. *Ann Surg Oncol* 2015;22(Suppl. 3):S1028–33.
- [5] Hammoudi K, Pinlong E, Kim S, Bakhos D, Morinière S. Transoral robotic surgery versus conventional surgery in treatment for squamous cell carcinoma of the upper aerodigestive tract. *Head Neck* 2015;37:1304–9.
- [6] Laccourreye O, Hans S, Ménard M, Garcia D, Brasnu D, Holsinger FC. Transoral lateral oropharyngectomy for squamous cell carcinoma of the tonsillar region: II. An analysis of the incidence, related variables, and consequences of local recurrence. *Arch Otolaryngol Head Neck Surg* 2005;131:592–9.
- [7] Adelstein DJ, Ridge JA, Brizel DM, Holsinger FC, Haughey BH, O'Sullivan B, et al. Transoral resection of pharyngeal cancer: summary of a National Cancer Institute Head and Neck Cancer Steering Committee Clinical Trials Planning Meeting, November 6–7, 2011. Arlington, Virginia. *Head Neck* 2012;34:1681–703.
- [8] Aubry K, Vergez S, de Mones E, Morinière S, Choussy O, Malard O, et al. Morbidity and mortality revue of the French group of transoral robotic surgery: a multicentric study. *J Robot Surg* 2016;10:63–7.
- [9] Razafindraly V, Lallemand B, Aubry K, Morinière S, Vergez S, De Mones E, et al. Clinical outcomes of transoral robotic surgery for supraglottic squamous cell

- carcinoma: experience of a french evaluation cooperative subgroup of gettec. *B-ENT* 2015;Suppl24:37–43.
- [10] Nickerson EK, Sinha R. Vertebral osteomyelitis in adults: an update. *Br Med Bull* 2016;117:121–38.
- [11] Urrutia J, Zamora T, Campos M. Cervical pyogenic spinal infections: are they more severe diseases than infections in other vertebral locations? *Eur Spine J* 2013;22:2815–20.
- [12] Espitalier F, de Keating-Hart A, Morinière S, Badet J-M, Asseray N, Ferron C, et al. Cervical spondylodiscitis following an invasive procedure on the neopharynx after circumferential pharyngolaryngectomy: a retrospective case series. *Eur Spine J* 2016;25:3894–901.
- [13] Stramandinoli E, Ayache S, de la Roche Saint Andre G, Strunski V. Cervical spondylodiscitis: a rare complication of phonatory implants. *Ann Otolaryngol Chir Cervicofac* 2001;118:382–5.
- [14] Bolzoni A, Peretti G, Piazza C, Farina D, Nicolai P. Cervical spondylodiscitis: a rare complication after phonatory prosthesis insertion. *Head Neck* 2006;28:89–93.
- [15] Holmgaard R, Jakobsen LP. Cervical spondylodiscitis—a rare complication of palatopharyngeal flap surgery. *Cleft Palate-Craniofacial J* 2008;45:674–6.
- [16] Gerometta A, Bittan F, Rodriguez Olaverri JC. Postoperative spondylodiscitis. *Int Orthop* 2012;36:433–8.
- [17] Lallemand B, Morinière S, Ceruse P, Lebalch M, Aubry K, Hans S, et al. Transoral robotic surgery for squamous cell carcinomas of the posterior pharyngeal wall. *Eur Arch Otorhinolaryngol* 2017;274:4211–6.
- [18] Cottle L, Riordan T. Infectious spondylodiscitis. *J Infect* 2008;56:401–12.
- [19] Shousha M, Heyde C, Boehm H. Cervical spondylodiscitis: change in clinical picture and operative management during the last two decades. A series of 50 patients and review of literature. *Eur Spine J* 2015;24:571–6.
- [20] Gradoni P, Oretti G, Ferri A, Ferri T. Pyogenic spondylodiscitis and osteoradionecrosis of the cervico-thoracic spine: a rare complication after surgery and radiation for hypopharyngeal cancer. *Acta Bio-Medica Atenei Parm* 2013;84:72–5.
- [21] Lukens JN, Lin A, Gamerman V, Mitra N, Grover S, McMenamin EM, et al. Late consequential surgical bed soft tissue necrosis in advanced oropharyngeal squamous cell carcinomas treated with transoral robotic surgery and postoperative radiation therapy. *Int J Radiat Oncol Biol Phys* 2014;89:981–8.
- [22] Weinstein GS. Transoral Robotic Surgery (TORS) - Gregory Weinstein - Livres [Internet]. [cité 7 mai 2018]. Disponible sur : <https://www.amazon.fr/Transoral-Robotic-Surgery-Gregory-Weinstein/dp/159756074X>.
- [23] SPILF. Spondylodiscites infectieuses primitives, et secondaires à un geste intradiscal, sans mise en place de matériel. *Recommand Med Mal Infect* 2007;37:573–83, <http://dx.doi.org/10.1016/j.medmal.2007.03.007>.