

Accepted Manuscript

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PII: S1529-9430(16)30201-7
DOI: <http://dx.doi.org/doi: 10.1016/j.spinee.2016.05.015>
Reference: SPINEE 57040



To appear in: *The Spine Journal*

Received date: 20-12-2015
Revised date: 26-4-2016
Accepted date: 23-5-2016

Please cite this article as: Hisse Arnts, Ronald H.M.A. Bartels, Flexible dropped head deformity following laminectomy for cervical spondylotic myelopathy: a case series and review of literature, *The Spine Journal* (2016), <http://dx.doi.org/doi: 10.1016/j.spinee.2016.05.015>.

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1 **Flexible dropped head deformity following laminectomy
2 for cervical spondylotic myelopathy: a case series and
3 review of literature**

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12 Word count: 2450

13 Number of references: 11

14 Number of figures: 1 (a,b,c)

15 Number of tables: 1

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21 **Abstract**

22 **Background context:** Flexible dropped head deformity (FDHD) following
23 laminectomy for cervical spondylotic myelopathy is a debilitating entity. Patients
24 need to support their head manually to look forward in standing or sitting
25 position. FDHD is different from rigid dropped head deformity in patients with
26 post-laminectomy kyphosis or ankylosing spondylitis and has only once been
27 described after surgery to the cervical spine.

1 **Purpose:** To report a rare, but severe complication of cervical posterior
2 decompressive surgery, to describe its possible etiology, and to review the
3 literature on the management of FDHD in order to provide recommendations for
4 its treatment.

5 **Study design:** A retrospective clinical case series.

6 **Patient sample:** This sample comprises four patients with FDHD.

7 **Methods:** We retrospectively reviewed the charts with clinical follow-up data of
8 all patients that underwent posteriorly directed spinal interventions and
9 concomitantly developed FDHD and were admitted between January 1998 and
10 September 2015.

11 **Results:** Cervical decompressive laminectomy is regularly performed in our
12 institution. Four patients with FDHD were identified (3 males and 1 female). The
13 overall prevalence was less than 1% (= 4 of 460 total estimated CSM surgeries).
14 FDHD developed within weeks or months after surgery. One patient was treated
15 conservatively, whereas the other three received surgery to reconstruct stability
16 of the cervical spine. Two of the surgically corrected patients eventually required
17 revision surgery as a result of failure of the hardware and because of skin
18 erosion.

19 **Conclusions:** FDHD is a rare, but serious complication of posterior
20 decompressive surgery. Its etiology appears multifactorial. Its management
21 needs to be directed towards early surgical intervention.

22

23 **Key words:** cervical spine; kyphosis; dropped head syndrome (DHS);
24 laminectomy; laminoplasty.

1

Abbreviations: dropped head syndrome (DHS), flexible dropped head deformity (FDHD), cervical spondylotic myelopathy (CSM).

4

5 Introduction

6 Dropped head syndrome (DHS) is a debilitating condition that is characterized by
7 severe weakness of the extensor muscles of the cervical spine. This weakness
8 causes the inability to keep the neck in a neutral position and often results in a
9 characteristic chin-on-chest deformity in standing or sitting position. DHS has
10 been associated with various conditions, but is usually caused by severe systemic
11 neuromuscular disorders, such as motor neuron disease, myasthenia gravis and
12 inflammatory myopathy [1]. Progressive forward tilt of the neck and kyphosis are
13 also well-known to occur as complication of posteriorly directed cervical spinal
14 interventions, such as laminectomy and laminoplasty [2]. However, these
15 patients have a fixed head position as a result of structural changes in the
16 cervical spine. Flexible dropped head deformity (FDHD) is totally different. The
17 neck deformity is correctable with passive neck extension and is not necessarily
18 accompanied by structural changes, although weakness of the neck extensor
19 muscles may eventually contribute to cervical segmental instability and
20 accelerate degenerative transformation. Patients with FDHD often need the use
21 of both hands to support their head and keep horizontal gaze in the upright
22 position. It therefore results in serious physical and social invalidity. In contrast
23 to rigid cervical kyphosis, FDHD has only once been described after a standard
24 laminectomy for cervical spondylotic myelopathy (CSM) [3]. In this case-series,
25 we present four patients with FDHD following (multilevel) laminectomy for CSM
26 with special emphasis on its etiology and treatment.

1

2 **Patients and methods**

3 After institutional review committee approval, the senior author's database was
4 used to identify all patients with FDHD, who previously underwent posterior
5 decompressive surgery for CSM in our primary (Radboud University Medical
6 Centre) and secondary (Canisius Wilhelmina Hospital) neurosurgical center. We
7 retrospectively reviewed the charts with all clinical follow-up of the patients
8 admitted between January 1998 and July 2015. Radiographs and magnetic
9 resonance imaging (MRI) were routinely performed preoperatively. Postoperative
10 radiographs were made in all patients and follow-up outpatient visits with
11 radiological evaluation of cervical alignment were routinely arranged after 3, 12
12 and 24 months. All patients with FDHD received neurological work-up with
13 laboratory investigations and electromyography (EMG) to exclude the presence
14 of neuromuscular disease or other extrinsic causes for deformity.

15

16 **Results**

17 Four patients with FDHD following conventional non-instrumented (multilevel)
18 laminectomy for CSM were identified at our institution (Table 1). All had the
19 same characteristics, which we will summarize, after which we will discuss one
20 case in more detail. In all instances, the symptoms and signs developed
21 gradually, but soon after the laminectomy (weeks-months). All patients were
22 unable to hold their head upright without manual assistance, and they had to
23 actively support their head bimanually. This contributed to social isolation, since
24 activities, such as dining with friends could not be performed properly. After a
25 longer period of conservative management, consisting of a hard collar and
26 physiotherapy in order to strengthen muscles, all patients were offered fusion to

1 correct the deformity and support stability. One patient refused surgical
2 correction. He was treated conservatively, consisting of a treatment with both
3 hard and soft neck collars, and multidisciplinary pain management. A solely
4 posterior surgical intervention was performed in only one case. In the other two
5 patients, a 360-degrees reconstruction was performed. In the patient with the
6 posterior approach, the construct failed, which was managed by a 360-degrees
7 approach with anterior cervical discectomies and fusion with cages followed by
8 re-exploration of the posterior construct and replacement of the broken implant.
9 Another surgically treated patient experienced disabling extensor muscle atrophy
10 with ulceration of the skin. Therefore, he underwent surgery with transposition of
11 a musculocutaneous latissimus dorsi flap, reduction of cervical spinous processes
12 and partial extirpation of posterior pedicle-screws. At final follow-up (24-72
13 months postoperatively) the surgically treated patients were satisfied, because
14 they did not experience the consequences of a dropped head, and were able to
15 have normal daily activities, despite some residual symptoms of CSM (Table 1).
16

17 **Case presentation**

18

19 **Case 1**

20 A 45-year-old female patient presented with symptoms and signs of CSM (Fig.
21 1a). An uneventful C3-C6 non-instrumented laminectomy was performed with
22 removal of the upper part of C7, leaving the muscle attachments to the spinous
23 process intact. After several months, outpatient follow-up revealed that she had
24 increasing difficulties keeping her head in upright position. She needed the use of
25 both hands to extend the neck and leaned back in her chair to compensate for
26 her cervicothoracic kyphosis. Examination revealed a characteristic flexible

1 dropped head, but she was able to actively extend her neck for a short period of
2 time (< 1 minute). MRI showed C2-C3 and C7 myelomalacia with atrophy of the
3 spinal cord, but no evidence of progression of myelopathy or structural kyphotic
4 changes (Fig. 1b). At EMG, evidence of neuromuscular disease could not be
5 detected. The patient preferred conservative treatment, consisting of a hard
6 (Philadelphia) neck collar and multidisciplinary pain-treatment including cervical
7 peripheral nerve blocks. During the following months, muscle strength, fine
8 motor skills and coordination further decreased. Eventually, she could only walk
9 for 50 meters and needed the use of a cane for long walks. The dropped head
10 and loss of horizontal gaze made her feel socially isolated, as she was not
11 capable of dining and have conversations with friends and family. She finally
12 agreed with a 360-degrees fusion. An anterior discectomy with fusion of C2-C7
13 and posterior fusion of C2-Th3 was performed and the stability restored (Fig.
14 1c). Postoperatively, her pain decreased and strength in both arms and legs
15 improved. After one-year follow-up, she is still satisfied and can participate in
16 social activities.

17

18 **Discussion**

19 The exact prevalence of FDHD after conventional laminectomy or laminoplasty is
20 unknown. In a recent evaluation of complications after cervical laminectomy
21 none of the patients suffered from FDHD [4]. In a review of DHS, cervical
22 laminectomy was not mentioned as a cause of a flexible dropped head [1,5].
23 Therefore, we think this case series is unique. In the Netherlands, most patients
24 are referred to the surgeon who operated them initially, and we were therefore
25 really confident that the number of patients with FDHD was representative for
26 our practice. Earlier, we calculated that in a three year period (2009-2012) 80

1 patients underwent a laminectomy for CSM in our institution [6]. Since the rate
2 of dorsal procedures for CSM did not change, nor did the technique, we
3 estimated that between 1998 and 2015 approximately 460 cervical
4 laminectomies were done solely for CSM. The overall prevalence for this entity in
5 the total cohort in this time period was 0,87%. Therefore, this complication
6 seems rare, and, though not unknown to the spine surgeon, has only once been
7 described in a patient who underwent a cervical laminectomy for CSM [3]. The
8 exact pathophysiology remains unclear. A flexible dropped head might be a
9 presentation of various neuromuscular diagnoses. In the report by Petheram et
10 al., a relation with CSM or more specifically post-laminectomy was not made [7].
11 In our patient that was treated conservatively, a search for a neuromuscular
12 diagnosis did not reveal anything specific, except nonspecific, non-inflammatory,
13 myopathic changes at muscle biopsy.
14 There have been multiple reports that relate FDHD to CSM and describe patients
15 that fully recover after posterior decompressive surgery [8-10]. It has been
16 suggested that cervical spondylosis may have caused preferential denervation
17 and weakness of the posterior cervical muscles by compromising the
18 microcirculation of the anterior horn cells of the spinal cord. When FDHD
19 develops, patients actively try to extend their cervical spine in order to preserve
20 horizontal gaze and compensate for their kyphotic deformity. This might result in
21 narrowing of the anterior-posterior diameter of the spinal canal, which negatively
22 influences both myelopathy and head drop [8]. In our cases, not the myelopathy,
23 but the laminectomy itself seemed to be the primary cause of FDHD. For
24 instance, there were no signs of FDHD before the initial procedure and
25 radiological post-procedural follow-up showed significant reduction of spinal cord
26 narrowing without evidence of progression of myelopathy. However, in two of our

1 four cases, evidence of post-laminectomy 'draping' of the spinal cord across the
2 posterior aspect of the vertebral bodies of the cervical spine can be seen (Fig.
3 1b). This 'draping' of the spinal cord may have compromised the microvascular
4 supply of the cord as a result of flattening of small feeder vessels [11].
5 Moreover, cervical flexion is known to increase longitudinal cord tension due to
6 the tethering effect of the dentate ligaments and cervical roots. The combination
7 of ischemia and cord tension might have caused direct neuronal injury with
8 concomitant muscle weakness, and eventually cervical deformity and
9 development and progression of FDHD in these patients.

10 It could be hypothesized that as a result of the laminectomy, the posterior
11 tension band was severely damaged, thereby inducing kyphosis. The muscle
12 attachments to C2 were left intact in all patients, because C2 was not involved,
13 though two of the four patients initially underwent a complete C7 laminectomy,
14 thereby disrupting extensor muscle support. As a result of the combination of
15 weakened strength due to surgery, but also due to neuronal injury as described
16 above, the gravitational force of the head will move forward. The lever arm will
17 elongate and therefore more strength was needed to keep the head upright and
18 in balance. In case of FDHD, the balance between lever arm, center of
19 gravitational center and muscle strength is lost. This hypothesis can be the base
20 for formulating a treatment algorithm.

21 The necessity to offer a solution was, in our opinion, obvious. FDHD not only
22 caused severe physical, but also social invalidity. Difficulties existed when
23 performing daily activities and self-care tasks, such as getting dressed and
24 having dinner and conversations with family and friends. Finding a solution for
25 FDHD certainly can improve the quality of life. The first option could be training
26 the muscles to increase strength and restore the balance. Support by an external

1 brace and pain management might be helpful. In the series by Petheram et al. of
2 DHS not related to previous surgery, three out of six cases noticed mild
3 improvement, whereas the others did not improve. The final case underwent
4 surgery with a dissatisfying result [7]. If the conservative strategy fails, surgery
5 could be an option. In our opinion, especially due to the longer lever arm, a 360-
6 degrees fusion should be performed in order to diminish movement within the
7 anterior column by removing softer discs and replacing them by stiffer materials
8 (cages). This will create less stress on a posterior construct with a long lever
9 arm, since the construct will include the cervicothoracic junction [1]. In our
10 patient treated by a posterior approach alone, the construct failed. This could be
11 explained by the mechanism of persisting laxity of the anterior column. Finally,
12 all of our surgically treated patients were satisfied because they could participate
13 in all kind of activities.

14

15 **Conclusion**

16 FDHD is a rare, but severe complication of cervical laminectomy for CSM.
17 Patients with FDHD are different from those with similar deformities because of
18 the flexibility, whereas progressive post-laminectomy kyphosis or kyphosis
19 related to ankylosing spondylitis is rigid. The etiology of FDHD still remains
20 obscure, but seems to involve a multifactorial process consisting of structural
21 myelopathic changes to the cervical spine and a vicious circle of biomechanical
22 factors, muscle damage, fatigue and pain. If left untreated, FDHD can cause
23 severe physical and social invalidity. After a conservative treatment,
24 management could be directed towards early surgical intervention, consisting of
25 a 360-degrees fusion with extension through the transitional cervicothoracic zone
26 in order to acquire durable correction of sagittal cervical alignment.

27

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4

5 **Figure legends**

6

7 **Figure 1A.** Pre-operative MRI-scan showing signs of cervical spondylotic
 8 myelopathy (CSM).

9

10 **Figure 1B.** Postoperative MRI-scan showing C7 myelomalacia, but no evidence
 11 of progression of myelopathy or structural kyphotic changes.

12

13 **Figure 1C.** Radiograph after cervicothoracic fusion.

14

15 **Table 1:** Patients with flexible dropped head deformity (FDFD) after laminectomy for CSM

| # | Age/ sex | Lev els | Onset | Severity | Conser vative | R x 1 | Rx2 | F U | Final outcome |
|---|-------------|------------|---|--|--|--------------------|---|--------|---|
| 1 | 45/F | C3- C7 | Gradually, y, in 3 months PO | Chin-on- chest deformity, actively correctable (<1 minute) | Philadel phia collar, PT, peripher al nerve blocks | PA P | - | 2 4 | Complete reduction of flexion deformity, moderate improvement of complaints |
| 2 | 51/M | C3- C7 | Gradually, y, in 3-6 months PO | Chin-on- chest deformity, passively correctable | Philadel phia collar, PT | P | Posterior revision and extension PSF to Th2, ASF C2-C5 with cages and allograft | 7 2 | Good improvement, minor pain, reduction of flexion deformity |
| 3 | 71/M | C5- C7 | Acute, in 2-6 weeks PO | Chin-on- chest deformity, passively correctable | Philadel phia/ soft collar, PT | C | - | 2 4 | Significant flexion deformity, complaints of pain and decrease of strength and sensibility |

| | | | | | | | | | | |
|---|------|-------|-----------------------------|--|------------------------------|----|---|---|---|--|
| 4 | 57/M | C3-C6 | Gradually, in 3-6 months PO | Chin-on-chest deformity, passively correctable | Philadelphia/soft collar, PT | AP | Partial extirpation of instrument Th1-Th3, reduction of C7-T1 spinous processes | 2 | 4 | Moderate improvement of complaints, reduction of flexion deformity |
|---|------|-------|-----------------------------|--|------------------------------|----|---|---|---|--|

1 PO = postoperatively, Rx = reoperation, PT = physiotherapy, PAP = posterior-anterior-posterior, P
 2 = posterior only, C = conservative, AP = anterior-posterior, FU = follow-up in months.
 3