

Could anterior cervical fixation be an alternative method in the management of Hirayama disease?

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Research Article

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Abstract

The study aimed to evaluate the clinical efficacy and feasibility of surgical treatment for Hirayama disease (HD) by anterior cervical fixation (ACF). From August 2008 to November 2015, 13 patients (12 males and 1 female, average age, 16.3 ± 1.1 years) with HD underwent ACF. Surgery-related indexes, clinical efficacy, and radiographic parameters were used to evaluate the clinical outcomes of surgery. The surgery duration time range from 67 to 128 min (average 89.2 ± 19.9 min) and the blood loss range from 40 to 120 ml (average 68.1 ± 26.3 ml). Four patients got resolved tremor, and the other patients stopped progressing. Grip strength significantly improved from preoperative 15.6 ± 1.7 kilogram to postoperative 18.6 ± 1.9 kilogram ($P < 0.001$). The cross-sectional areas of the spinal cord at C6 and C7 levels increased from 0.7 ± 0.1 cm² to 0.8 ± 0.1 cm² ($P = 0.018$) and from 0.6 ± 0.2 cm² to 0.7 ± 0.1 cm² ($P = 0.049$) respectively. The cervical lordosis increased from $2.4 \pm 3.4^\circ$ to $7.0 \pm 3.5^\circ$ ($P = 0.001$). The range of cervical flexion was significantly decreased from preoperative $31.3 \pm 11.5^\circ$ to postoperative $14.3 \pm 7.5^\circ$ ($P < 0.001$). No surgical related complications such as hoarseness, cerebral fluid leakage, and surgical site infection were observed after surgery. Two patients, felt abnormal sensation of throat occasionally, showed screw loosening and internal fixators were removed finally. Although screw loosening was observed, ACF could serve as an effective treatment in the management of the HD.

Introduction

Hirayama disease (HD), first reported in 1959[7], is also known as juvenile muscular atrophy of the distal upper extremities, which usually affects young males in their second decade. The disorder is featured with progressing muscular atrophy in forearms and hands, followed by a plateau of symptom within 5 years after onset[7]. Symptoms, like cold paralysis, fasciculation, and tremor, are also noted in HD patients[4, 18]. The other feature of HD is an anterior shifting of the posterior dural sac during neck flexion, which leads to spinal cord compression against the vertebral body. Repetitive microtraumas to the anterior horn motor neurons during neck flexion are now considered as the possible pathogenesis of the disorder[10, 16]. In view of this, cervical collars, which could restrain the neck flexion, have been widely used in the treatment of HD and brought out favorable outcomes[4]. Although cervical collars are regarded as the mainstay of the treatment, surgical interventions are well established as an alternative for HD patients who are in advanced conditions, irresponsive to conservative treatment, or intolerant to cervical collars[5, 8, 12, 15]. Therefore, this study aims to evaluate the clinical efficacy and feasibility of ACF for HD.

Materials And Methods

Patient population

This was a retrospective, clinical study. The study was approved by the ethics committee of The First Affiliated Hospital of Fujian Medical University. From August 2008 to November 2015, 19 HD patients underwent ACF in The First Affiliated Hospital of Fujian Medical University. Six patients were excluded

from the study due to lost to follow-up. The diagnosis was based on Hirayama's clinical diagnostic criteria[6, 20]. Surgery was performed on patients who cannot tolerate the use of cervical collars or with progressing symptoms. Detailed patient information is shown in **Table 1**.

Operative technique

Surgery was performed under general endotracheal anesthesia. All patients were placed in the supine position with the neck mildly extended. A transverse incision was made in the anterior right side of the neck. Then, tissues were separated layer by layer, until targeted spinal segments were reached. Targeted spinal segments were confirmed by a intraoperative fluoroscopy and fixed with titanium plate and screws.(**Fig. 1**)

Postoperative management

After surgery, we monitored the vital signs of patients and directed them to expel sputum. The drainage tube was removed when the volume of drainage was less than 30 ml/24 h. The patients were allowed to turn in bed on the first postoperative day, sit with a cervical collar on the second postoperative day, and then encouraged to stand or walk. All patients took X-rays of the cervical spine at one week, three months, six months and twelve months after surgery, and then once a year thereafter. Neuron nutrition drugs (mecobalamin, 1.5 mg/day) were prescribed to accelerate neurological recovery and rehabilitation exercise was carried out for all patients during the early stage of recovery.

Statistical Analysis

All continuous data were presented as mean \pm SD. All data were statistically analyzed using SPSS 21.0 software (IBM Corp., Armonk, NY, USA). To compare the preoperative, postoperative clinical and radiological data, the Paired Sample t-test was used, and a p value < 0.05 was considered statistically significant.

Results

Surgical Outcome

All patients were followed up for 75.9 ± 33.2 months (range from 34 to 128 months) postoperatively. The surgery duration time range from 67 to 128 min(average 89.2 ± 19.9 min)and the blood loss range from 40 to 120 ml(average 68.1 ± 26.3 ml).(Table 1) Four patients got resolved tremor, and the other patients stopped progressing. Grip strength significantly improved from preoperative 15.6 ± 1.7 kilogram to postoperative 18.6 ± 1.9 kilogram ($P < 0.001$). The cross-sectional areas of the spinal cord at C6 and C7 levels increased from 0.7 ± 0.1 cm² to 0.8 ± 0.1 cm² ($P = 0.018$) and from 0.6 ± 0.2 cm² to 0.7 ± 0.1 cm² ($P = 0.049$) respectively. The cervical lordosis increased from $2.4 \pm 3.4^\circ$ to $7.0 \pm 3.5^\circ$ ($P = 0.001$). The range of cervical flexion was significantly decreased from preoperative $31.3 \pm 11.5^\circ$ to postoperative $14.3 \pm 7.5^\circ$ ($P < 0.001$). (Table 2) No surgical related complications such as hoarseness, cerebral fluid leakage,

and surgical site infection were observed after surgery. Two patients, felt abnormal sensation of throat occasionally, showed screw loosening and internal fixators were removed at final follow-up. (Fig. 2)

Discussion

Hirayama disease, mainly found in Asia, is a rare cervical myelopathy that predominantly affects young men (male-to-female ratio of 20:1). Due to fact that the disease tends to stabilize naturally within 5 years, conservative treatment remains the mainstay for the treatment. For patients who are intolerant of wearing cervical collars or patients with progressing symptoms, surgical treatment is still required. The aim of surgery for HD patients is to restrict cervical flexion and eliminate compression of spinal cord. Chiba et al. [3] reported that advanced HD patient had successful improvement of daily activities after operative reconstruction. However, as different surgical techniques have been effectively practiced in HD patients, which one is the ideal is still debatable. Arrese et al.[1] performed laminectomy and duraplasty without spinal fusion to increase the room for the spinal cord. Brandicourt et al.[2] reported 3 patients treated by posterior cervical decompression with coagulation of the epidural venous plexus. Although aforementioned posterior approaches brought out satisfying outcomes, posterior decompression destroyed the integrity of spine and compromised the spinal stability. But, to our knowledge, no literature in surgical treatment for HD by ACF had been reported. The purpose of this study was to evaluate the clinical efficacy and feasibility of ACF for HD by means of surgery-related indexes, clinical efficacy, and radiographic parameters.

Lin et al.[13] suggested that anterior decompressive approach can achieve good outcomes and no significant complications for HD patients with disc protrusion, cervical instability, or severe cervical kyphosis. Limitations of anterior cervical fusion are also apparent. Song J et al.[17] suggested that the bone graft fusion may lead to permanent activity limitation and induce degenerative process at adjacent levels due to the biomechanical changes. What is more, to our knowledge, anterior decompressive approach will cause a high rate of pseudarthrosis due to the issue of incomplete decompression, limited visual exposure, and injury to the cord. Due to the absence of discectomy or corpectomy and bone fusion, ACF could significantly reduce intraoperative blood loss and operation time.

In this study, we quantitatively assessed and compared the grip strength of upper extremities, range of cervical flexion, cross-sectional areas of spinal cord, and cervical lordosis before and after surgery.

Wang et al.[19] reported improvement of grip strength after anterior cervical approach, which was also observed in the present study. Koutsis et al.[11] described that spinal cord compression caused by anterior shift of dural sac during neck flexion induced the finger tremor in HD patients. Due to the restriction to cervical flexion, spinal cord compression was eliminated after surgery. As a result, 4 patients got resolved tremor, and the other patients stopped progressing in the present study. The symptoms, including oblique atrophy, cold paralysis, fasciculation, were not observed in all HD patients in our study. Xu X et al.[22] demonstrated an increased flexed motion range of cervical spine, which would aggravate the forward displacement of posterior dura mater, and lead to trauma to the anterior portion of the spinal

cord for HD patients. Postoperative range of cervical flexed motion was significantly decreased in the present study.

Misra et al.[14] reported that more than two-thirds of HD patients have segmental cord atrophy that was most pronounced at the level of C6 and C7 vertebral body. The cross-sectional areas of spinal cord of C6 and C7 were significantly increased after surgery. The concept of sagittal balance has been proposed for cervical spine treatment. Cervical lordosis is used to determine the sagittal balance of the cervical spine[9]. Improvements of radiographic parameters were observed in terms of the cross-sectional area of spinal and cervical lordosis, indicating ACF can achieve satisfactory outcomes. Therefore, ACF was able to provide favorable clinical efficacy as well as radiographic improvements for HD patients.

The most commonly reported complications associated with the anterior cervical surgical approach are postoperative dysphagia, hematoma and recurrent laryngeal nerve palsy[21]. In our study, no patient occurred severe complications such as postoperative dysphagia, hoarseness, cerebral fluid leakage and infection after surgery. Nevertheless, two patients, felt abnormal sensation of throat occasionally, showed screw loosening. Since HD is a self-limiting disease, ACF can prevent the progression of HD, and then internal fixator could be removed when the disease stabilized in order to reduce the risk of other complications such as dysphagia or esophageal fistula.

There are several limitations to our study. Firstly, this study was a single-center and retrospective study rather than a prospective study which existed selection bias. Secondly, HD is so rare that a small number of patients were enrolled. Thirdly, although our cases showed a satisfactory outcome, it should be prudent when making a decision of surgical interference. Further comparative studies are required to compare surgery with conventional cervical collar therapy.

Conclusion

ACF was able to provide favorable clinical efficacy as well as radiographic improvements for HD patients. Although screw loosening was observed, ACF could serve as an effective treatment in the management of the HD.

Declarations

Funding

No funding was received for this research.

Availability of data and material (data transparency)

All data used by or generated in this study is available from the corresponding author upon reasonable request.

Code availability

Not applicable.

Conflict of interest

The authors declare that they have no competing interests.

Ethical approval

This study was approved by the Ethics Committee of First Affiliated Hospital of Fujian Medical University.

Consent to participate

Signed written informed consents were obtained from all participants before the study.

Consent for publication

All participants gave written informed consent for their personal or clinical details along with any identifying images to be published in this study.

Authors' Contribution

The authors' contributions to this study were as follows: WCW, ZCL and HJZ contributed equally to the study design. WCW, ZCL, RQL and JHL contributed to the data collection and statistical analysis. All authors wrote and approved the manuscript.

References

1. Arrese I, Rivas JJ, Esteban J, Ramos A, Lobato RD (2009) A case of Hirayama disease treated with laminectomy and duraplasty without spinal fusion. *Neurocirugia (Astur)* 20:555-558; discussion 558 <https://doi.org/10.1212/wnl.13.5.373>
2. Brandicourt P, Sol JC, Aldéa S, Bonneville F, Cintas P, Brauge D (2018) Cervical laminectomy and micro resection of the posterior venous plexus in Hirayama disease. *Neurochirurgie* 64:303-309 <https://doi.org/10.2169/internalmedicine.39.283>
3. Chiba S, Yonekura K, Nonaka M, Imai T, Matumoto H, Wada T (2004) Advanced Hirayama disease with successful improvement of activities of daily living by operative reconstruction. *Intern Med* 43:79-81 <https://doi.org/10.1080/14660820500396877>
4. Hirayama K (2000) Juvenile muscular atrophy of distal upper extremity (Hirayama disease). *Intern Med* 39:283-290 <https://doi.org/10.3346/jkms.2016.31.10.1664>
5. Hirayama K (2000) Juvenile muscular atrophy of distal upper extremity (Hirayama disease): focal cervical ischemic poliomyelopathy. *Neuropathology* 20 Suppl:S91-94 <https://doi.org/10.1212/01.wnl.0000068017.75780.44>
6. Hirayama K (2008) [Juvenile muscular atrophy of unilateral upper extremity (Hirayama disease)—half-century progress and establishment since its discovery]. *Brain Nerve* 60:17-29

<https://doi.org/10.3171/2013.10.SPINE13508>

7. HIRAYAMA K, TSUBAKI T, TOYOKURA Y, OKINAKA S (1963) Juvenile muscular atrophy of unilateral upper extremity. *Neurology* 13:373-380 <https://doi.org/10.14245/ns.1836178.089>
8. Ito H, Takai K, Taniguchi M (2014) Cervical duraplasty with tenting sutures via laminoplasty for cervical flexion myelopathy in patients with Hirayama disease: successful decompression of a "tight dural canal in flexion" without spinal fusion. *J Neurosurg Spine* 21:743-752 <https://doi.org/10.1046/j.1440-1789.2000.00305.x>
9. Jun HS, Kim JH, Ahn JH, Chang IB, Song JH, Kim TH, Park MS, Kim YC, Kim SW, Oh JK (2015) T1 slope and degenerative cervical spondylolisthesis. *Spine (Phila Pa 1976)* 40:E220-226 <https://doi.org/10.3171/2014.7.SPINE13955>. Epub 2014 Sep 5
10. Kim J, Kim Y, Kim S, Oh K (2016) Hirayama Disease with Proximal Involvement. *J Korean Med Sci* 31:1664-1667
11. Koutsis G, Velonakis G, Breza M, Karavasilis E, Zambelis T, Panas M (2016) Neck flexion-induced finger tremor: A novel observation in Hirayama disease. *J Neurol Sci* 364:42-44 <https://doi.org/10.3171/spi.2005.3.2.0086>
12. Kuo YH, Kuo CH, Huang WC, Wu JC (2019) Anterior Cervical Discectomy and Fusion for Hirayama Disease: A Case Report and Literature Review. *Neurospine* 16:626-630 <https://doi.org/10.2169/internalmedicine.43.79>
13. Lin MS, Kung WM, Chiu WT, Lyu RK, Chen CJ, Chen TY (2010) Hirayama disease. *J Neurosurg Spine* 12:629-634
14. Misra UK, Kalita J, Mishra VN, Kesari A, Mittal B (2005) A clinical, magnetic resonance imaging, and survival motor neuron gene deletion study of Hirayama disease. *Arch Neurol* 62:120-123 <https://doi.org/10.1016/j.neuchi.2018.04.004>. Epub 2018 Jun 14
15. Paredes I, Esteban J, Ramos A, Gonzalez P, Rivas JJ (2014) A severe case of Hirayama disease successfully treated by anterior cervical fusion. *J Neurosurg Spine* 20:191-195 <https://doi.org/10.3171/2009.12.SPINE09431>
16. Restuccia D, Rubino M, Valeriani M, Mirabella M, Sabatelli M, Tonali P (2003) Cervical cord dysfunction during neck flexion in Hirayama's disease. *Neurology* 60:1980-1983 <https://doi.org/10.1016/j.wneu.2018.03.152>
17. Song J, Zhang YX, Song KH, Wang HL, Zou F, Jiang JY (2018) Risk Factors of Adjacent Segment Disease After Anterior Cervical Arthrodesis: A Retrospective Study of Sagittal Measurement of Thoracic Inlet Parameters. *World Neurosurg* 114:e1094-1094e1100 <https://doi.org/10.1016/j.wneu.2018.05.045>
18. Tashiro K, Kikuchi S, Itoyama Y, Tokumaru Y, Sobue G, Mukai E, Akiguchi I, Nakashima K, Kira J, Hirayama K (2006) Nationwide survey of juvenile muscular atrophy of distal upper extremity (Hirayama disease) in Japan. *Amyotroph Lateral Scler* 7:38-45 <https://doi.org/10.1016/j.jns.2016.03.012>

19. Wang HL, Wu YW, Song J, Jiang JY, Lu FZ, Ma XS, Xia XL (2018) Cortical Activation Changes in Hirayama Disease After Anterior Cervical Decompression and Fusion. *World Neurosurg* 116:e588-588e594 <https://doi.org/10.1016/j.ejrad.2010.08.012>. Epub 2010 Aug 30
20. Watanabe K, Hasegawa K, Hirano T, Endo N, Yamazaki A, Homma T (2005) Anterior spinal decompression and fusion for cervical flexion myelopathy in young patients. *J Neurosurg Spine* 3:86-91 <https://doi.org/10.1001/archneur.62.1.120>
21. Willson MC, Ross JS (2014) Postoperative spine complications. *Neuroimaging Clin N Am* 24:305-326 <https://doi.org/10.1097/BRS.0000000000000722>
22. Xu X, Han H, Gao H, Hou C, Fan D, Fu Y, Sun Y (2011) The increased range of cervical flexed motion detected by radiographs in Hirayama disease. *Eur J Radiol* 78:82-86 <https://doi.org/10.1016/j.nic.2014.01.002>

Tables

Table 1: Parameters and surgical outcomes of surgery

Case	Sex	Age (y)	Tremor	Operative time (min)	Blood loss (ml)	Follow-up time (months)	Fixaion segments
1	M	15	Yes	128	80	122	C5-T1
2	M	15	Yes	92	40	121	C4-7
3	M	16	Yes	108	120	103	C4-7
4	M	18	Yes	75	50	43	C4-6
5	M	16	Yes	90	40	62	C4-7
6	M	16	No	80	50	51	C3-6
7	F	16	Yes	67	80	46	C4-7
8	M	15	No	95	100	39	C3-6
9	M	18	Yes	78	50	34	C4-6
10	M	17	No	75	75	95	C4-7
11	M	16	Yes	80	50	90	C4-7
12	M	18	Yes	124	100	60	C4-7
13	M	16	Yes	68	50	50	C4-7
Mean		16.3 ± 1.1		89.2 ± 19.9	68.1 ± 26.3	75.9 ± 33.2	

Table 2 Clinic and radiographic outcomes of surgery

Case	Grip strength(kg)		The cross-sectional areas of the spinal cord				Cervical lordosis(°)		Range of cervical flexion(°)	
	Preop.	Postop.	Preop.at C6	Postop. at C6	Preop.at C7	Postop. at C7	Preop.	Postop.	Preop.	Postop.
1	16.5	18.9	0.79	0.82	0.63	0.76	3.2	5.7	32.18	19.61
2	14.3	16.7	0.71	0.75	0.58	0.57	4.3	6.3	40.35	20.43
3	17.8	21.2	0.86	0.69	0.74	0.62	0.46	12.8	5.81	3.26
4	15.4	19.6	0.57	0.75	0.63	0.7	-2.6	4.3	31.63	9.65
5	12.2	14.5	0.86	0.86	0.82	0.82	4.4	6.1	35.97	14.59
6	17.4	21.3	0.79	0.72	0.68	0.63	4.7	4.8	48.85	18.64
7	17.8	20.7	0.61	0.76	0.5	0.76	5.9	9.4	37.95	17.41
8	16.6	19.3	0.68	0.66	0.72	0.69	7.6	11.5	19.1	7.63
9	15.1	17.4	0.54	0.66	0.37	0.62	2.3	10.7	39.63	32.33
10	13.2	16.7	0.83	0.9	0.76	0.82	-1.6	1.3	35.42	13.26
11	15.9	18.8	0.84	0.89	0.78	0.86	2.2	3.2	24.3	9.32
12	14.7	18.4	0.74	0.92	0.33	0.56	3.7	10.3	18.14	9.2
13	16.0	18.5	0.76	0.78	0.69	0.76	-3.7	5.2	37.14	10.35
Mean	15.6 ± 1.7	18.6 ± 1.9	0.7 ± 0.1	0.8 ± 0.1	0.6 ± 0.2	0.7 ± 0.1	2.4 ± 3.4	7.0 ± 3.5	31.3 ± 11.5	14.3 ± 7.5
P value	< 0.001*		0.018*		0.049*		0.001*		< 0.001*	

Preop.: Preoperative; Postop.: Post-operative

*: Analyzed by paired t-test, Postop. compared with Preop.

Figures

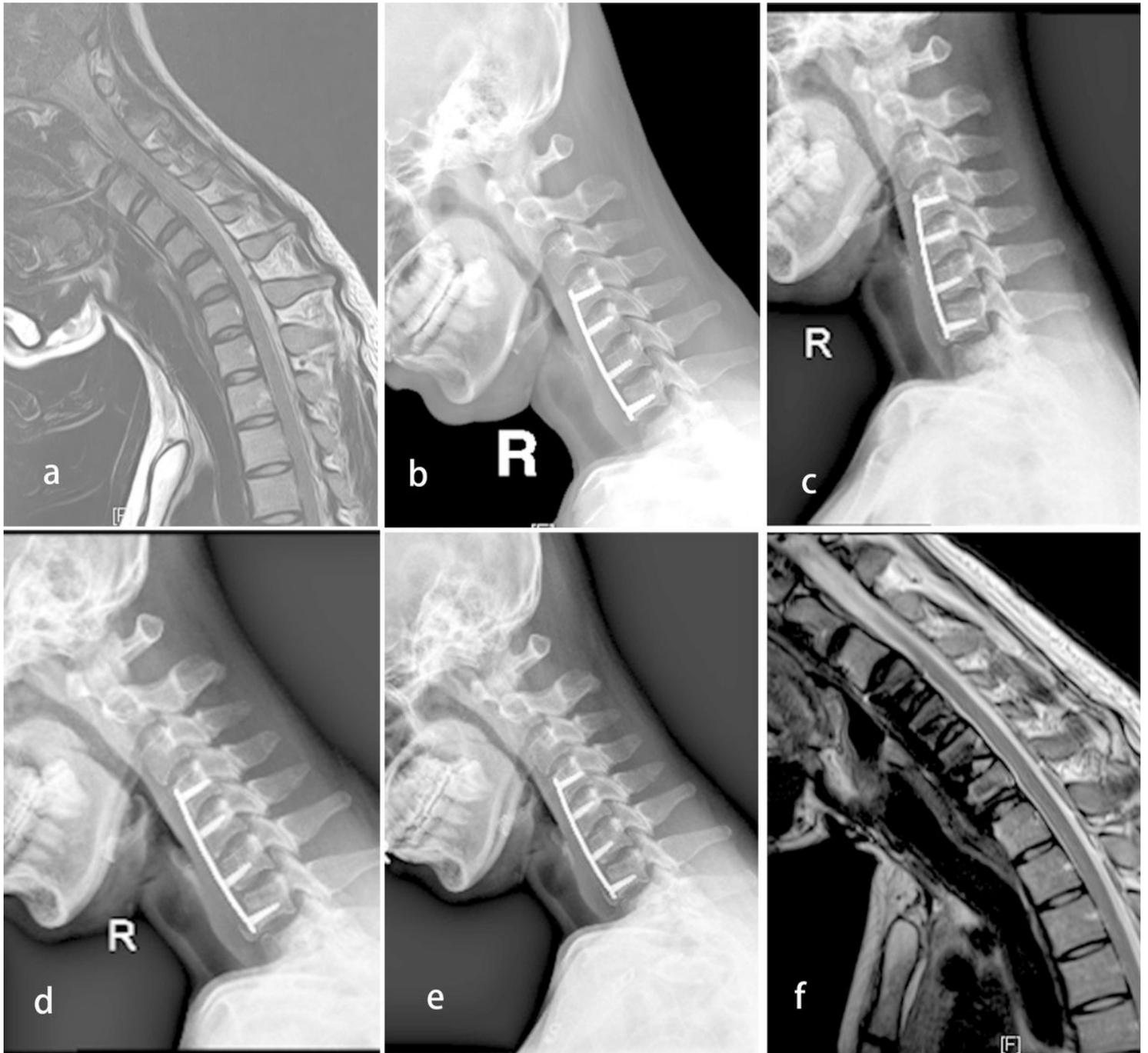


Figure 1

A 16 years old female patient underwent anterior cervical fixation. Preoperative neck-flexed MRI (a) showed cord atrophy of C4 to C7 and posterior epidural vasodilatation. Postoperative one week (b), three months (c), one year (d) and two years (e) hyperflexion radiographs showed the good internal fixation position after surgery. At the final follow-up, neck-flexed MRI (f) showed the disappearance of cord atrophy of C4 to C7 and posterior epidural vasodilatation.

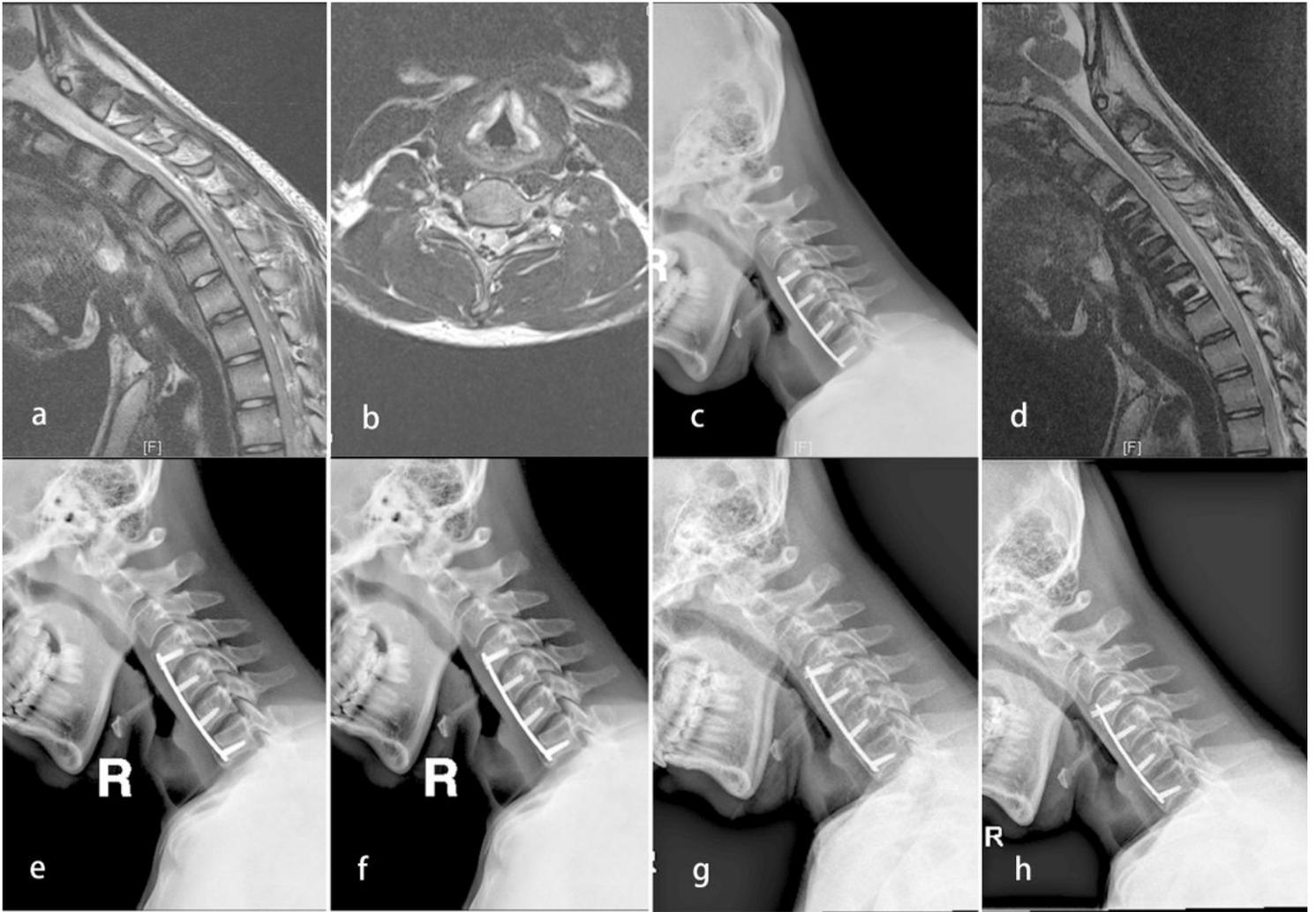


Figure 2

A 17 years old male patient underwent anterior cervical fixation. Preoperative neck-flexed MRI (a) and cross-sectional MRI (b) showed cord atrophy of C4 to C7 and posterior epidural vasodilatation. Postoperative one week hyperflexion radiograph(c) showed the good internal fixation position after surgery. Postoperative one year neck-flexed MRI(d) showed disappearance of cord atrophy of C4 to C7. Postoperative one year(e) and two years(f) hyperflexion radiographs showed the good internal fixation position. Postoperative three years(g) and final follow-up(h) hyperflexion radiographs showed screw loosening.