Original Article

Hirayama's disease: an Italian single center experience and review of the literature

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Background: Hirayama's disease (HD), is a benign, self-limited, motor neuron disease, characterized by asymmetric weakness and atrophy of one or both distal upper extremities. In the present study we report the clinical, electrophysiological and MRI features of a group of Italian patients, with review of the literature. Moreover we propose an optimized MRI protocol for patients with suspected or diagnosed HD in order to make an early diagnosis and a standardized follow up.

Methods: Eight patients with clinical suspicion of Hirayama disease underwent evaluation between January 2007 and November 2013. All patients underwent standard nerve conduction studies (NCS), electromyography (EMG) and motor/sensory evoked potentials (MEP/SEP). Cervical spine MRI studies were conducted with a 1.5 Tesla MRI scanner in neutral and flexion position, including sagittal T1-weighted sequences and sagittal and axial T2-weighted sequences. The following diagnostic features were evaluated: abnormal cervical curvature, localized cervical cord atrophy in the lower tract (C4–C7), presence of cord flattening (CF), intramedullary signal hyperintensity on T2 weighted sequences, anterior shifting of the posterior wall of the cervical dural sac (ASD) and presence of flow voids (EFV) in the posterior epidural space during flexion.

Results: All patients complained of weakness in hand muscles as initial symptoms, associated with hand tremor in three of them and abnormal sweating of the hand palm in two of them. No sensory deficits and weakness at lower limbs were reported by any patients. Distal deep tendon reflexes at upper limbs were absent in all patients with the absence of the right tricipital reflex in one of them. Deep tendon reflexes at lower limbs were normal and no signs of pyramidal tract involvement were present. The clinical involvement at onset was unilateral in six patients (three left-sided and three right-sided) and bilateral asymmetric in two of them, with the right side more affected. With the progression of the disease all patients but one experienced weakness and wasting of hand muscles and forearm bilaterally, but still asymmetric. The duration of the progression phase of the disease ranged from eight months to three years. In all patients, NCS and EMG findings were consistent with a spinal metameric disorder involving the C7-T1 myotomes bilaterally; sensory conduction and electrophysiologic features at lower limbs were normal. MEP and SEP were normal and we did not observe the disappearance of the spinal potential during the neck flexion in any of the patients. MRI is the best diagnostic tool in the diagnosis of HD; it can confirm clinical diagnosis and exclude other conditions responsible for the neurological deficits leading to a correct patient management and therapy, limiting arm impairment. On MRI all patients had loss of the normal cervical lordosis (100%). Five patients had loss of attachment of posterior dural sac and anterior dural shift on flexion MRI with presence of flow voids from venous plexus congestion (62.5%); three patients had no anterior dislocation of the dural sac and no epidural vein congestion. Two patients showed localized cord atrophy, one at C5–C6 and the other at C6–C7 level (25%). Three patients had T2 intramedullary hyperintensities (37.5%) and

cord flattening (CF) was present in 5 patients of 8 (62.5%).

Conclusions: HD is a rare entity and a self-limited condition, but it has to be early differentiated from other diseases that may determine myelopathy and amyotrophy to establish a correct therapy and limit arm impairment. MRI is very important to confirm the clinical suspect of HD and a standardized MRI protocol using axial and sagittal images in both neutral and flexing position is needed, in order to diagnose and follow up affected patients.

Keywords: Magnetic resonance imaging (MRI); Hirayama's disease (HD); spinal cord; atrophy

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Introduction

Hirayama's disease (HD), also known as "juvenile muscular atrophy of distal upper extremity" (JMADUE), was first described by Hirayama *et al*. in 1959 (1). Since then, the greatest number of cases have been reported from Japan and other Asian countries (1-6); in contrast, it is less common among the population of the North America and Europe, however lately some case series were published (7-10). Some case reports were reported in Italy (11-13) but to our knowledge this is the first reported Italian group of patients with HD.

The disease affects young people, predominantly men, in the second to third decades of life and it is characterized by an insidious onset, unilateral or bilateral asymmetric (rarely bilateral symmetric) weakness and atrophy of the forearm and hand with sparing of the brachioradialis muscle giving the characteristic appearance of oblique amyotrophy (14).

HD is a benign, self-limiting pathology; after a progressive phase of the neurological deficits affecting the C7, C8 and T1 myotomes for about 1–5 years, it has a spontaneous arrest (15). The first autopsy obtained in 1982 from a patient died of lung carcinoma, revealed antero-posterior flattening and ischemic changes in the anterior horn cells of the lower cervical cord segment (16).

HD is thought to be a flexion myelopathy related to forward displacement of the posterior wall of the lower cervical dural canal with neck flexion, but this theory is strongly debated (12,17). HD is predominantly sporadic and familial occurrence is very rare, but documented (1,17). Magnetic resonance imaging (MRI) features have been described in literature to aid the diagnosis of HD. In the present study we report our experience of HD and review the clinical, electrophysiological and MRI features, in both neutral and neck flexed position, of a group of Italian patients. Finally we propose an optimized MRI protocol for patients with suspected or diagnosed HD in order to make an early diagnosis and a standardized follow up.

Methods

Eight patients (6 males, 2 females; age range 15–23 years) with clinical suspicion of Hirayama disease underwent clinical, electrophysiological and MRI diagnostic evaluation between January 2007 and November 2013 at University Hospital Federico II, Naples, Italy. We obtained written informed consent from all of our patients.

Diagnostic inclusion criteria for HD were (18,19): (I) weakness and atrophy of the upper limbs interesting predominantly forearms and hands; (II) unilateral or bilateral asymmetric signs and symptoms; (III) insidious onset in the teens or early 20's; (IV) absence of substantial sensory and reflexes abnormalities of pyramidal tracts, lower limbs, cranial nerves, sphinterial or cerebellar deficits; (V) progression for few years followed by arrest of the disease; (VI) electromyography (EMG) evidence of the chronic denervation at C7-T1 myotomes; (VII) exclusion of other diseases.

MRI studies of cervical spine (C-spine) were conducted with a 1.5 Tesla MRI scanner (Intera, Philips, Best, The Netherlands) in the neutral position as follows: sagittal T1-weighted sequences [turbo spin echo, repetition time (TR) ms/echo time (TE) ms of 400/10], sagittal T2-weighted sequences in all patients (TR/TE 3,500/120); in four patients axial T2-weighted sequences (TR/TE 3,000/120)

Table 1 MR signs of HD evaluated on neutral and neck-flexed position

MR-sign	MR-position
Anterior dural shifting	Flexion
Epidural flow-voids	Flexion
Cord flattening	Neutral or flexion
Localized cord atrophy	Neutral
Abnormal cervical curvature	Neutral
T2- hyperintensities	Neutral

MR, magnetic resonance; HD, Hirayama's disease.

were performed.

The flexion MRI imaging protocol of cervical spine consisted for all patients in: sagittal T2-weighted sequences (TR/TE 3,500/120) and axial T2-weighted sequences (TR/TE 3,750/120). Neck-flexion was obtained positioning a head-sponge with an angulation between 25–35 degrees (depending on patient conformation and collaboration).

The section thickness was 4mm, for both sagittal and axial MR imaging in all sequences in neutral and flexed position.

The following diagnostic features were evaluated (*Table 1*): abnormal cervical curvature, localized cervical cord atrophy in the lower tract (C4–C7), presence of CF, intramedullary signal hyperintensity on T2 weighted sequences, anterior shifting of the posterior wall of the cervical dural sac (ASD) and presence of flow voids (EFV) in the posterior epidural space during flexion.

Cervical curvature was considered normal when the vertebral bodies C3 through C6 were anterior to a line drawn from C2 through C7. An abnormal, straight or kifotic, curvature was defined when part or all of the vertebral bodies from C3 to C6 met or crossed the line from C2 to C7.

Localized cervical cord atrophy was defined as a decrease in cord size in comparison with the normal cord above and that below the affected level on sagittal and/or axial images (4).

CF was defined as loss of the normal ovoid spinal cord configuration without a narrowed or obliterated adjacent subarachnoid space; a pear-shaped spinal cord was considered as asymmetric CF and a triangular spinal cord was considered as symmetric CF. CF was evaluated on sagittal and axial images; if neutral images were not available, this was assessed on sagittal and axial flexion images.

Intramedullary hyperintesity was considered on axial and/or sagittal T2 images if intramedullary high signal intensity was noted without evidence of other causes of cord compression.

Anterior shifting of posterior dural sac (ASD) and presence of abnormal epidural flow voids (EFV) were evaluated on flexion MRI studies. ASD was defined as an abnormal detachment and anterior dislocation of the posterior wall of dural sac during neck flexion with enlargement of posterior epidural space. EFV, if present, was suggestive of engorgement of posterior epidural venous plexus.

Results

Demographics and clinical features (Table 2)

Patients were prevalently males (male/female ratio =3/1) with mean age of 17.8 years at the time of clinical presentation. All patients were white and two of them were brothers. Mutations in the glycyl-tRNA synthetase (*GARS*) gene were excluded in the familial case.

All patients complained of weakness in hand muscles as initial symptoms, associated with hand tremor in three of them and abnormal sweating of the hand palm in two of them. No sensory deficits and weakness at lower limbs were reported by any patients. Distal deep tendon reflexes at upper limbs were absent in all patients with the absence of the right tricipital reflex in one of them. Deep tendon reflexes at lower limbs were normal and no signs of pyramidal tract involvement were present. The clinical involvement at onset was unilateral in six patients (three left-sided and three right-sided) and bilateral asymmetric in two of them, with the right side more affected. With the progression of the disease, all patients but one experienced weakness and wasting of hand muscles and forearm bilaterally, but still asymmetric (with the onset side more affected than the other one). The duration of the progression phase of the disease ranged from eight months (1 patient) to three years (3 patients).

Electrophysiological findings

All patients underwent standard nerve conduction studies (NCS), EMG and motor/sensory evoked potentials (MEP/SEP).

In all patients, NCS and EMG findings were consistent with a spinal metameric disorder involving the C7-T1 myotomes bilaterally (prevalent on the right side in three patients and on the left in two). Sensory conduction and

Table 2 Overview on patient population

Patient number	Onset			CI	PPD (months)	Clinical features (weakness and atrophy)			Absent TR	Tremors
	Age (years)	Side	SS			Hands intrinsics MM	Fingers extensors MM	Biceps/triceps brachii MM		
1	19	Bilateral	Tremor and hand weakness	Yes (L > R)	12	No	Yes (L>R)	No	Distal reflexes at upper limbs	Yes (bilateral)
2	15	Bilateral	Tremor and hand weakness	Yes (R > L)	36	Yes (R > L)	Yes (R > L)	No	Distal reflexes at upper limbs	Yes (R hand)
3	17	R	Progressive hand weakness	Yes	36	Yes (R > L)	Yes (R > L)	Yes (tricipital)	Distal reflexes at upper limbs and R tricipital	No
4	18	R	Hyperhidrosis and hand weakness	Yes	12	No	Yes (R > L)	No	Distal reflexes at upper limbs	No
5	17	R	Progressive hand weakness	Yes	12	Yes	Yes	No	Distal reflexes at upper limbs	No
6	23	L	Tremor and hand weakness	Yes	36	Yes	Yes	No	Distal reflexes at upper limbs	Yes (L > R)
7	16	L	Hyperhidrosis and hand weakness	Yes	24	Yes	Yes	No	Distal reflexes at upper limbs	No
8	18	L	Progressive weakness	Yes	8	Yes	Yes	No	Distal reflexes at upper limbs	No

SS, signs and symptoms; CI, contralateral involvement; PPD, progression phase duration; MM, muscles; TR, tendon reflexes, L, left; R, right.

Table 3 MR findings of HD in neutral and neck-flexed position in our patients

Patient number	ASD	EFV	CF	LCA	T2 HT	ACC
1	Yes	Yes	Yes	No	No	Yes
2	No	No	No	No	No	Yes
3	Yes	Yes	Yes	Yes	Yes	Yes
4	Yes	Yes	Yes	Yes	Yes	Yes
5	No	No	No	No	Yes	Yes
6	No	No	No	No	No	Yes
7	Yes	Yes	Yes	No	No	Yes
8	Yes	Yes	Yes	No	No	Yes

MR, magnetic resonance; HD, Hirayama's disease; ASD, anterior shifting of posterior dural sac; EFV, epidural flow-voids; CF, cord flattening; LCA, localized cord atrophy; T2 HT, T2 hyperintensities; ACC, abnormal cervical curvature.

electrophysiologic features at lower limbs were normal. MEP and SEP were normal and we did not observe the disappearance of the spinal potential during the neck flexion in any of the patients.

Cervical MRI findings (Table 3)

All patients had loss of the normal cervical lordosis (100%) (*Figure 1*).

Five patients had loss of attachment and anterior dural shift on flexion MRI with presence of flow voids from venous plexus congestion (62.5%) (*Figure 2*); three patients had no anterior dislocation of the dural sac and no epidural vein congestion.

Two patients showed localized cord atrophy, one at C5–C6 and the other at C6–C7 level (25%). Three patients had T2 intramedullary hyperintensities (37.5%) (*Figure 3*), in both neutral and flexion position.

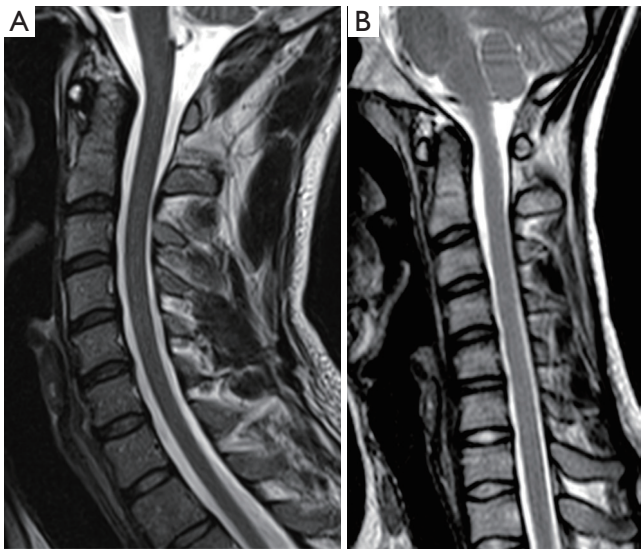

Figure 1 T2-weighted sagittal in (A) normal individual showing normal cervical lordosis; (B) patient with HD showing loss of cervical lordosis. HD, Hirayama's disease.

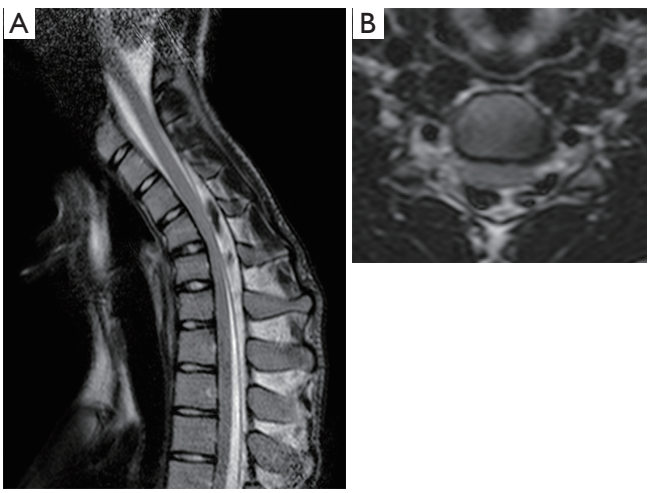

Figure 2 T2-weighted sequence on sagittal (A) and axial (B) planes. Posterior detachment and forward shifting of the dural sac with presence of epidural flow-voids from posterior venous plexus congestion, during neck-flexion (A). Antero-posterior cord flattening is evident on the axial plane (B).

CF was present in 5 patients of 8 (62.5%).

Other findings were: 3 patients presented slight intersomatic disc protrusions: 1 patient between C4 and C5, 2 patients between C6 and C7 and 1 patient at C3–C4 level,

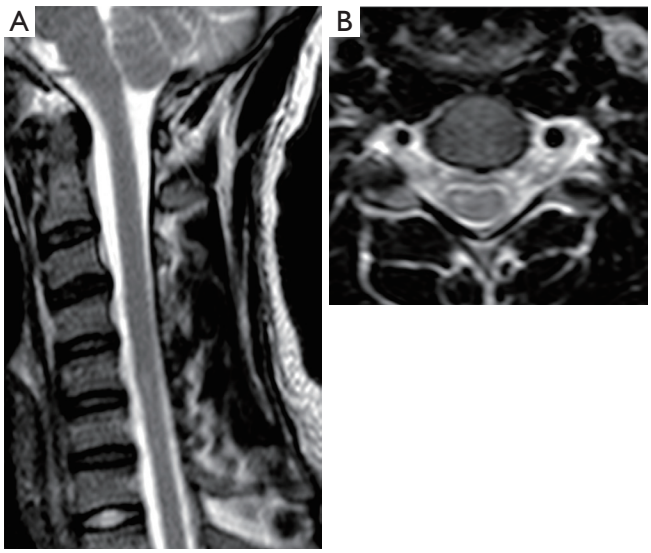

Figure 3 T2-weighted sequence on sagittal (A) and axial (B) planes. Right-sided intramedullary hyperintensity at the level of C5–C6.

present in both neutral and flexion position.

Treatment

Patients received no treatment for their neurological deficits. Some of them were proposed to undergo collar therapy, but they were not compliant and suspended the therapy after few months. One patient underwent surgical treatment with duraplasty. The progression of the disease ranged from eight months to three years.

Discussion

HD is a benign, self-limited, motor neuron disease, characterized by asymmetric weakness and atrophy of one or both distal upper extremities. Its pathogenesis is strongly debated. The main hypothesis is that HD is a myelopathy related to flexion movements of the neck, during which there is a forward displacement of a tight dural sac compressing the cervical cord (18). The compression would lead to an increased intramedullary pressure causing microcirculatory disturbance in the anterior horn. Hirayama *et al*. speculated that disproportionate growth between the vertebral column and its canal contents during growth spurt, could cause a tight dural sac leading to the flexion myelopathy (1). Strenuous exercise of the arms and

repeated neck flexions, were noted in affected patients and speculated as risk factors (5,20).

Nevertheless some studies showed no substantial clinical and radiological modifications with neck flexion and contradict this hypothesis (12,17).

Some authors proposed atopy and elevated IgE serum levels as participating factors, based on the evidence of some cases of atopic myelitis and a higher frequency of allergic diseases and hyperIgEaemia in patients with HD; some patients had also more severe disabilities (21-24). An involvement of intrathecal immune/inflammatory process was proposed by Tanaka *et al*. (25), that revealed intrathecal upregulation of IFN-gamma and MIP-1beta in HD patients.

Gamez *et al*. (26) revealed no relationship between HD pathogenesis and *SMN1/SMN2* genes, associated with some motor neuron diseases.

From a clinical point of view, HD has a stationary stage after a progressive phase of the neurological deficits interesting the C7, C8 and T1 myotomes of about 1–5 years.

The disease affects young people, predominantly men, in the second to third decades of life and is characterized by the insidious onset of predominantly unilateral or bilateral asymmetric weakness and atrophy of the distal forearm and hand including thenar, hypothenar, interossei muscles and wrist flexors and extensors, with sparing of the brachioradialis muscle. This topography gives the characteristic appearance of "oblique amyotrophy" (1).

The duration of the progressive phase of the disease in our population was between eight months and three years and the presence of weakness and atrophy of forearm and arm was consistent with the literature; in our series, the most common symptom at onset was weakness (50%). All our patients had the classic pattern of "oblique amyotrophy".

Other typical clinical features include "cold paresis", worsening of symptoms with cold exposure, and no abnormalities of tendons reflexes, sensory disturbance and pyramidal signs (14,15,27).

Muscular impairment could be initially unilateral, with right upper limb more frequently affected, but secondary asymmetric bilateral involvement is possible (28). Rarely, symptoms could be bilateral and symmetric (1) with a reported prevalence from 3% to 10% (5). In our series, unilateral involvement at onset was present in six patients. Two patients had bilateral involvement, in one case at onset; in both, impairment was asymmetric with right side more affected.

Atrophied muscles can show signs of acute or chronic denervation at EMG and reduction of amplitude of compound muscle action potentials; nevertheless, in patients with unilateral amyotrophy, homonymous muscles of the unaffected side can show denervation. In about 25–50% of cases non-atrophic muscles of the affected side sometimes can show denervation (i.e., triceps brachii, brachioradialis, biceps brachii and deltoid muscles). Motor nerve conduction velocities are usually normal (1,29).

Motor evoked potential after transcranial magnetic stimulation shows an increased latency and decreased amplitude which is temporally aggravated by neck flexion.

During the progressive phase of the disease, neck flexion could lead to a decrease of F-wave persistency; other features are increased latency and high amplitude waveform suggesting denervation/reinnervation. In patients with severe wasting, the F-wave may become unrecordable (27).

Contrariwise, Misra *et al*. and Ammendola *et al*. found no significant differences between standard and flexed position for F-wave parameters, suggesting a different etiology for HD than flexion myelopathy (2,12). Hassan *et al*. and Ghosh *et al*. showed no electromyographic abnormalities of C5 and C6 myotomes (27,28).

In our series chronic denervation at EMG of C7, C8 and T1 myotomes was evident in all patients; C5 and C6 were spared. Electromyographic abnormalities were bilateral, but some patients had right (3) or left (2) prevalence, in agreement with their symptoms. No sensitive conduction abnormalities were found.

Diagnostic imaging is very important to support clinical suspect of HD. Conventional radiographic examinations of the cervical spine may show loss of cervical lordosis (27) or a hyperflexed cervical motion rate (30). In the 80's, myelography and CT-myelography, in neutral and neck flexed position, were used to evaluate patients with suspected HD demonstrating atrophy of the lower cervical cord and forward displacement of a tightened dural sac (14). However, myelography is an invasive investigation that needs to retain the contrast medium in the subarachnoid space during neck flexion, so it is hard to perform. On axial images at CT myelography asymmetric CF could be seen, with epidural space appearing as an area of hypodensity behind the dura (31).

MRI is the best diagnostic tool in the diagnosis of HD; it is a non-invasive modality that can reveal some features when performed in neutral and neck-flexion position. MRI can confirm clinical diagnosis and exclude other conditions responsible for the neurological deficits leading to a correct patient management and therapy, limiting arm impairment.

Forward shifting of the posterior dural sac and engorgement of posterior epidural venous plexus are considered the characteristic signs of HD in flexion cervical MRI (1,15,32).

Some authors (31,33,34) reported the presence of forward shifting of the dural sac in all their patients. Nevertheless this sign is not always present in HD patients. Zhou *et al*. and Lheman *et al*. reported a prevalence respectively of 71% and 76% (10,35). Interestingly, Lai *et al*. (36) demonstrated the presence of anterior shifting of posterior dural sac in 46% of healthy subjects, of a lesser degree compared to patients group and without evidence of cord compression. Nonetheless, they suggested that forward shifting of the posterior dural sac on neck flexion can occur as normal variation and its presence does not always lead to diagnosis of HD. In our series anterior displacement of posterior cervical dural sac was present in five of eight patients, a percentage consistent with the literature. Hou *et al*. (37) postulated that neck flexion angle had effects on the presence of anterior dural shift, evidence of cervical epidural space and flow voids; they suggest a flexion of 25 degrees at least, 35 degrees as the best choice.

In patients with HD an engorged epidural venous plexus was seen in MRI flexion studies; five of eight patients had this sign in our study. These vascular changes were confirmed by angiographic and CT-venography exams (11,38,39) and a possible additional role had been proposed to concur with the arterial ischemia in the pathogenesis of HD. Venous engorgement is suspected to be secondary to some co-existing mechanisms such as an impaired venous drainage toward the jugular veins during neck flexions and an increased flow to posterior internal vertebral venous plexus resulting from the negative pressure in posterior epidural space as a result of anterior shifting of the dura (11,27). Nevertheless, in a case report, Patel *et al*. (40), showed no change in venous epidural pressure in the flexed position suggesting a passive dilatation of the epidural plexus. Recently, Gupta *et al*. utilized the 3D-CISS sequence to enhance the presence of the epidural flow voids, because it allows better cerebrospinal fluid to tissue contrast (41). On flexion sagittal T1-weighted images, posterior detachment with forward shifting of the dural sac allows to observe a widened posterior epidural space appearing as a low intensity "crescent shaped epidural mass" with flow voids and uniform enhancement of this crescentic area on post-contrast images (4,6,31,41).

Among the other MRI features, asymmetric CF, localized lower cervical cord atrophy and loss of posterior dural attachment have a reported accuracy of about 80% in HD diagnosis (27,42).

Chen *et al*. (42) proposed loss of attachment with the subjacent lamina (LOA) as the most reliable sign on neutral position cervical MRI; they reported a prevalence in their series of 93% among the patients group. Because of the rarity of HD in Europe and Italy we did not use standardized MRI protocols and we could not evaluate LOA because of the lack of axial T2-weighted images in neutral position for all patients. So, despite of its rarity, we want to underline the importance of suspecting Hirayama's disease and establishing standardized MRI protocols to research diagnostic features on both axial and neck-flexed position. We suggest that every patient with a clinical suspect of HD would undergo the following MR C-spine protocol including at least:

Sagittal T1-weighted and T2-weighted sequences and axial T2 or T2*-weighted sequence in neutral position; sagittal T2-weighted sequences and axial T2 or T2*-weighted sequence in a neck- flexion of 35 degrees as best choice, at least 25 degrees (being the axial T2 or T2*-weighted sequence during flexion perpendicular to the spinal cord). Sagittal T1-weighted sequences in neck-flexion before and after gadolinium intravenous administration could be added.

CF has a various prevalence in different case series. Yin *et al*., Hassan *et al*. and Raval *et al*. (6,27,31) reported a 100% of prevalence while Lehman *et al*. (10) and Yang *et al*. (32) found it respectively in 48% and 43%. Finsterer *et al*. (9) executed MRI studies in the neutral position and reported asymmetric CF only in one patient of seven. In our series, CF was present in five patients of eight (62.5%).

Localized cervical cord atrophy was reported by Hirayama and Tokumaru in about 50% of cases (14). Controversal results are present in literature. Sonwalkar *et al*. and Raval *et al*. (4,31) depicted cord atrophy in 100% of their patients, Hassan *et al*. in 82% of cases. Chen *et al*. demonstrated localized cervical cord atrophy only in their patients group (42). Among our patients, only two presented cervical cord atrophy, similar to results of Ghosh *et al*. that described it in 33% of cases (28).

Contrariwise to other studies, Boelmans *et al*. executed neutral position MRI in eight patients and no one of them had CF or localized cord atrophy. Diffusion tensor imaging (DTI) evaluation showed no alteration of the cortico-spinal tract confirming that HD is a primary spinal motor neuron disease (43). Recently, attention was pointed on the presence of a localized cord atrophy as a "sand-watch"—like pattern on sagittal images as a sign of disease (41,44).

All our patients had loss of normal cervical lordosis. In

agreement with our finding were the studies of Hassan *et al*. and Raval *et al*. that depicted loss of cervical curvature in 91% and 100% of their patients (27,31). Chen *et al.* in their series founded a statistically significant difference between healthy and patients group, with prevalence of this sign in the latter. Loss of cervical lordosis is thought to be in relationship with the presence of a tight dural sac in patients with HD (42).

Two of our patients (25%) showed T2 hyperintensities of the spinal cord respectively at C5–C6 and C6–C7 levels. High signal alterations on T2 weighted images without cord compression are described in the literature, but this finding is inconstant, presenting in about one third or less of the patients (10,27,34,42).

Syringomyelia, amyotrophic lateral sclerosis, cervical spondilosis associated with myelopathy, spinal cord tumor and traumatic myelopathy, may cause localized amyotrophy of the distal arm, and should be differentiated from HD by imaging modalities. In our familial case we looked for mutations in *GARS* to rule out distal spinal muscular motor atrophy type V (45).

Collar therapy or surgical intervention had been proposed as treatment for HD. Cervical collar is used to avoid neck movements and to prevent progressive muscular weakness at early stage of the disease with good response; its application for three to four years has been advocated (1,28,46). Surgical treatment with cervical spinal fusion and duraplasty had encouraging results in selected patients. Some authors report better outcomes in patients treated surgically than those treated conservatively (47,48). Particularly in patients that do not improve with collar therapy a surgical intervention could be beneficial, because it gives a permanent stable fixation with a shorter period of immobilization (27,49). Arrese *et al.* (50) executed in a case duraplasty without spinal fusion to avoid the spinal cord compression without limiting cervical motion; recently also Ito *et al*. (51) treated successfully six patients with duraplasty without spinal fusion, improving neurological deficits and supporting tight dural canal theory for HD. To all our patients it was suggested to avoid sports or situations that might induce neck trauma. Some of them were proposed to undergo collar therapy, but they were not compliant and suspended the therapy after few months. One patient underwent surgical treatment with duraplasty.

Conclusions

HD is a rare entity, more frequent in Japan and Asian countries, characterized by unilateral or bilateral asymmetric weakness and atrophy of the hands and forearms, particularly in men. It's a self-limited pathology, but it has to be differentiated early from other diseases that could determinate myelopathy and amyotrophy to establish a correct therapy and limit arms impairment.

MRI is very important to confirm clinical suspect of HD and a standardized MRI protocol using axial and sagittal images in both neutral and flexed position is needed in order to make diagnosis and to follow up affected patients.

Acknowledgements

None.

Footnote

Conflicts of Interest: The authors have no conflicts of interest to declare.

Ethical Statement: Our work is not an experimental protocol; we evaluated retrospectively our patients, so there is not an ethical committee approval. We obtained written informed consent from all of our patients.

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