International Journal of Academic Research and Development
ISSN: 2455-4197
Impact Factor: RJIF 5.22
www.academicsjournal.com
Volume 3; Issue 3; May 2018; Page No. 172-179

Clinicoradiological profile of Hirayama disease: An experience from a tertiary care centre in Kerala

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Abstract
Background: Hirayama disease (HD) is a benign disease characterized by unilateral or asymmetric distal upper limb weakness and wasting.
Objective: To study the clinical and radiological profile of patients with HD.
Materials and Methods: Clinicoradiological evaluation were done in a total of 8 patients presented with insidious-onset hand wasting from March 2015 to June 2017. Results: All were males, mean age of onset of 19.5 years. 7 out of 8 (87.5%) had asymmetric wasting and weakness. All (100%) had oblique amyotrophy, two (25%) had cold paresis, four (50%) had minipolymyoclonus, and 3 (37.5%) had history of trauma to cervical region. Flexion MRI contrast study showed enchancing epidural crescent with anterior displacement of posterior cervical dura in all patients.
Conclusion: Though Dynamic contrast MRI is characteristic, routine studies have a high predictive value for diagnosis. Prompt diagnosis is important to institute early collar therapy.

Keywords: hirayama disease, flexion MRI, oblique amyotrophy

1. Introduction
Hirayama disease (HD) is a rare disease affecting primarily young men in the second to third decades of life [1]. First reported in 1959 as "juvenile muscular atrophy of unilateral upper extremity in Japan". It is a segmental inferior cervical myelopathy predominantly occurring in young males and presenting with unilateral or asymmetric upper limb weakness and wasting that affects the C7-D1myotomes [2]. Characterized by insidious onset of atrophy and weakness, of distal upper limbs, electromyographic (EMG) evidence of neurogenic pattern without conduction block, and slow progression for 2–4 years followed by a stationary course. Also known as monomelic amyotrophy (MMA) [3], juvenile asymmetric segmental spinal muscular atrophy (JASSMA) [4] and juvenile muscular atrophy of the distal upper extremity (JMADUE) [5]. The muscle weakness and atrophy in the hand and forearm, with sparing of the brachioradialis, giving the characteristic appearance of oblique amyotrophy [6]. The amyotrophy is unilateral in most patients, asymmetrically bilateral in some and rarely symmetric [7]. Pathological hallmark is the necrosis of the anterior horn cells of the lower cervical cord due to chronic microcirculatory changes induced by the dynamic compression of the cervical spinal cord occur during repeated or sustained neck flexion [1, 7]. Forward displacement of the posterior wall of the lower cervical dural canal when the neck is in flexion, which causes marked, often asymmetric, flattening of the lower cervical cord is the pathogenetic mechanism attributed for HD [8, 9]. Its non progressive course and pathologic findings of chronic microcirculatory changes in the anterior horns of the lower cervical cord differentiates HD from other classical types of motor neuron diseases (MND) [1]. Early diagnosis of HD, based on clinical and imaging characteristics, is important so that timely intervention with cervical collar can be instituted to reduce the morbidity. The present study reviews the clinical and MRI features in HD in the neutral and flexion positions as well as documents subjective response to cervical collar therapy.

2. Materials and Methods
The study was conducted at a tertiary care hospital in kerala. 12 patients with clinical suspicion of HD were seen between March 2015 to June 2017. Out of this 2 patients were diagnosed to have hereditary neuropathy, 2 patients lost follow-up. Detailed clinicoradiological evaluations were done in the remaining 8 patients.
Inclusion criteria: a) insidious onset and slow progression of distal predominant weakness and wasting in a young patient, b) clinically confined predominantly to C7, C8 and T1 myotomes in one upper limb or asymmetrically in both upper limbs, c) absence of Hoffmann and Babinski signs, (d) cold paresis (mild transient worsening of symptoms on exposure to cold), (e) EMG evidence of chronic denervation in the clinically or subclinically affected muscles without evidence of conduction block, (f) neuroimaging not showing any compressive lesion affecting spinal cord, roots or plexus, and (g) absence of involvement of cranial nerves, pyramidal tracts, sensory, cerebellar and extrapyramidal systems.
After detailed clinical examination all patients underwent electrophysiological study including EMG and nerve conduction study (NCS). To look for any evidence of conduction block motor and sensory NCS were performed in all the four limbs. Needle EMG of the affected and unaffected muscles of the involved limb (C5 to T1 dermatome) were performed. Proximal and distal muscles of the uninvolved

limbs were also sampled. Hemogram, liver and renal function tests, creatine kinase (CPK) level, Serum IgE level were performed. Detailed radiological evaluation of cervical spine using plain X-ray, Magnetic resonance imaging (MRI) were done. MRI was performed on a 1.5 Tesla MRI machine. MRI of cervical spine was performed both in neutral and hyperflexion position of neck. Maximal possible hyperflexion of neck was achieved by asking the subject to first move the head as forwards as possible and then to touch the chin to the chest. The shoulders were pushed as far caudal as possible. The position was maintained by supporting the neck and shoulders with MR compatible foam pads. Post contrast imaging were taken after iv administration of MR contrast agent in the dose of 0.5 mmol/kg. The sequences performed in neutral position included Sagittal T1 and T2W, Axial T1, T2W, Gradient Echo (GRE), and Coronal STIR. The sequences performed in flexion of cervical spine included Sagittal and coronal T2W images. Postcontrast T1 fat saturation axial, sagittal and coronal sequences were done.

Following features were evaluated: a) localized cord atrophy, b) Cord Flattening, c) Anterior displacement of dorsal dura on flexion, d) Enhancing epidural component and its thoracic extension, e) Intramedullary signal abnormality, f) flow voids, and g) loss of lordosis.

Localized cord atrophy was defined as a decrease in cord size in comparison with the normal cord above and below the affected level on sagittal and transverse MR imaging [10]. Cord flattening was defined as flattening without a narrowed or obliterated adjacent subarachnoid space which was evaluated using transverse MR images. An elliptic spinal cord was considered normal, a pear-shaped spinal cord was considered asymmetric cord flattening and a triangular spinal cord was considered symmetric cord flattening [10]. By definition, normal lordotic cervical curvature is curvature in which no part of the dorsal aspect of the vertebral bodies C3 through C6 crosses the line from C2 through C7. Loss of lordosis means part or all of the dorsal aspects of the vertebral bodies C3 through C6 meet or cross through the line from C2 through C7. More than one-third loss of attachment between the posterior dural sac and the subjacent lamina was considered significant [10]. Lamina is the flattened or arched part of the vertebral arch, forming the roof of the spinal canal. Anterior displacement of dural sac and appearance of epidural flow voids with enhancing epidural component posterior to the thecal sac were assessed using flexion studies.

3. Results

Total 8 patients were evaluated. All of them were males. Mean age at onset of symptoms was 19.5 years, ranging from 13.6 years to 23 years. Mean age of patients during clinical examination was 25.9 years. The duration of illness at the time of presentation was ranging from 4 months to 22 years. 3 patients had symptoms duration of less than 1 years, 3 patients had symptoms duration of 10 years or more [table1].

All patients presented with insidious onset progressive lower motor neuron type of weakness and wasting of one or both upper limb. 7 out of 8 patients (87.5%) had asymmetric bilateral wasting and weakness and the remaining one unilateral (right) involvement. Among those with bilateral involvement, 4 patients had predominant involvement on the right. There was no history of neck pain or radicular pain in any of them.

Minipolymyoclonus was observed in four patients (50%), periscapular wasting in two patients (25%), and two patients (25%) had cold paresis. All (100%) had oblique atrophy of forearm and one (12.5%) had fasciculations. History of trauma to cervical region was obtained in three (37.5%) patients [table 2].

3.1 Electrophysiology

EMG showed chronic denervation changes in both upper limb muscles in 7 patients and only on the right side in the remaining one patient. Among this two patients (25%) had chronic denervation changes in C5 and C6 myotomes (namely deltoid, biceps brchii,and brachioradialis) in addition to C7,C8 and T1 myotomes. NCS didn't show partial or complete conduction block. Median and ulnar motor CMAPs were reduced to varying degree in all the patients. Sensory conduction study and, distal and F wave latencies in median and ulnar nerves were normal [table 3].

3.2 Neuroimaging findings

MR Imaging of cervical spine in the neutral position showed loss of lordosis in 7 patients (87.5%), asymmetrical cord atrophy with anterior posterior cord flattening observed in 7 (87.5%) patients, loss of attachment of posterior dural sac to adjacent lamina in 4 patients (50%),Intramedulary T2 hyperintensity in 2 (25%) patients. In flexion study all patients (100%) showed Enchancing epidural crescent with epidural flow voids and Anterior displacement of posterior cervical dura, thoracic extension of epidural crescent in 4 (50%) patients [table 4]. MRI features are shown in Figures 1–3.

Serum IgE levels and absolute eosinophil count (AEC) were elevated in 3 (37.5%) patients.

4. Discussion

HD is characterized by muscular weakness and wasting of the distal upper extremity, affecting young males between the ages of 15 and 25 years. It is a benign condition as evidenced from literature due to its slow progression over 2–4 years followed by a stationary course, lack of spread to the other limbs in the majority of patients and the restriction of the disease process to the lower motor neurons [11]. Age of onset of symptoms in all our patients was less 25 years with a mean age of 19.5 years, comparable with studies done by Hassan *et al*, We had 4 patients with disease duration of 5 years or more, of which only one (1 out of 4, 25%) had progression of symptoms after 5 years of onset of symptoms. One year follow up of other 4 patients with duration of symptoms less than 5 years, disease progression got arrested after using cervical collar. In a study done by Gourie-Devi M *et al* only 4.5%(2 of 44) patients progressed beyond 5 years, similarly 5% (1 of 20) by Hirayama *et al* [12]. Singh *et al* [13] did not observe progression beyond 5 years in all their 24 patients, however, in the series reported by Sobue *et al* [14] (nine of 71, 12.7%) and Peires *et al* [15] (26 of 102, 25%), a larger number had disease progression beyond 5 years. In these two reports, patients with bilateral involvement, either symmetrical or asymmetrical, formed a significant proportion of the series, similar to our study.

Most common clinical feature is insidious onset wasting and weakness of distal forearm and hand muscles. This amyotrophy can be unilateral, asymmetrically bilateral or rarely symmetrical. According to a study by Raval M *et al* [16] unilateral involvement was more common than bilateral involvement (89 % vs 11%). But other studies by Hassan KM *et al* [17] and Sonwalkar *et al* [18] showed that asymmetric bilateral involvement (55% and 75% respectively) was the most common clinical phenotype in patients with HD. This findings were consistent with our observation, that 7 out of 8 (87.5%) patients had asymmetrical bilateral involvement. It is interesting to note that Hirayama *et al* [12, 19] did not observe bilateral involvement. Also study by Gourie-Devi M *et al* [11] showed only eight patients (18.2%) out of 44 had asymmetric bilateral involvement. The right upper limb is more frequently involved in HD, regardless of handedness [12, 13, 15]. Our study also showed predominant right upper limb involvement 4 out 7 patients who had bilateral disease. Remaining patient had unilateral involvement on the right side. Huang YC *et al* noticed 3:1 predominance of right upper limb and two patterns of progression from one upper limb to the other. Muscle symptoms developed in the other arm during progression in the initially involved arm (with about a 1-year delay in onset), or approximately 2.5 years after cessation of progression in the first arm. Only one of our patient noticed the progression of symptoms to the other limb after about 1 ½ years in to the illness. Rest of the patient couldn't report the pattern of progression, possibly due to the slow progression of the disease. Recently, Pradhan *et al*. in their series of 106 patients of HD seen from 1992 to 2008 reported around 10% of all the patients to have bilaterally symmetric involvement, a severe form of classic HD, which remains undiagnosed due to a common notion that it is a unilateral or grossly asymmetric disease.

Patients may report cold induced worsening of weakness (cold paresis). Cold paresis was reported by 2 (25%) of our patients, compared to 36% and 55% respectively observed by Hassan KM *et al* and Raval *et al*. No associated sensory, cranial nerves or pyramidal tract involvement on follow up assessment. All of our patients were males, emphasizing the male preponderance of this condition. The degree of male preponderance reported in large series has ranged from purely male [20] to a male-to-female ratio of 2.8 [21].

Exact prevalence of this condition is not known. Most of the cases were reported from Asian countries. Out of 211 cases of motor neuron disease seen during a 10-year period from 1973 to 1982, at the National Institute of Mental Health and Neurosciences, Bangalore, India, HD was accounting for 12.8% (19) cases. In the etiopathogenesis of this disorder, vascular insufficiency of the spinal cord [22], heavy physical activity [23], focal cord atrophy [24, 25], as a result of stretching of the cord during flexion of the neck [26] and viral infections [27] have been considered, but as yet there is no convincing evidence to explain the unique geographic distribution and the predilection to Asians. One of the most widely discussed pathogenic concept of HD disproportionate growth of the vertebral column and the spinal cord, resulting in short tight dural sac, which get detached from its posterior anchor during neck flexion [4, 8, 28, 29]. Tight dural canal as the underlying predisposing factor was first proposed by Kikuchi *et al* [18] in 1987. The different growth rates between male and female patients have been proposed by Toma *et al* as the factor related to the male preponderance of HD. Juvenile growth spurt may further accentuates the disproportionate dural sac shortening, explain the preponderance in adolescence. Hirayama *et al* observed that onset age in patients with Hirayama disease is 2 years later than the peak age of a normal growth curve. Pathologic examination revealed shrinkage, necrosis and gliosis in the anterior horns of the spinal cord from C5 to T1, particularly marked at C7 and C8 [22]. Atopy and elevated serum IgE level have been proposed as the precipitating factors in patients with HD [30, 31]. Blood often stagnates in the compressed lower cervical cord allowing platelet aggregation and release of histamine, factors that cause arterial spasm and microcirculatory disturbances. Moreover, atopic disorders affect young people more than the elderly, men more than women, and Asians more than non-Asians may in part explain the distribution of HD.

Physiologically, the dural sac is held in place inside the vertebral canal by the nerve roots and the dural sheaths, which act as an anchor, and by attachment to the vertebral bodies at the foramen magnum, to the dorsal surface of vertebrae C2-3, and to the coccyx. The remaining dural sac is loosely suspended enclosed by epidural fat, venous plexus, and connective tissue [32]. The difference in length between extension and flexion from T1 to top of atlas is 5 cm at the posterior wall and 1.5 cm at the anterior wall [33]. As neck flexion results in an increase in the overall length of the vertebral canal, the loosely suspended dural sac is stretched but remains in close contact with the walls of the spinal canal without anterior displacement. But in HD, the dural sac is shorter in length and already tighter in the neutral position [32] (because of the disproportionate growth rates), resulting in detachment of the tight dura from its posterior anchor during neck flexion. Anterior displacement of the dura results in abutment of the spinal cord against the anterior vertebral column. Compression of the cord causes microcirculatory changes in the territory of the anterior spinal artery with consecutive severe ischemic changes and gliosis at the site of the abutment [34]. Anterior horn cells are vulnerable to ischemia, leading on to atrophy [1]. Dynamic compression of the lower cervical cord due to forward displacement of the posterior cervical dural sac and spinal cord on neck flexion was confined to an early and progressive stage of the disease [28].

Recurrent falls, excessive training in a fitness studio, competitive sport, or strenuous physical work were described in the literature as predisposing factors for the development of HD [35]. In a study on 40 HD patients 37.5% had participated in vigorous sport or physical activity for at least 6 months prior to onset of HD [36]. In our study three (37.5%) patients had history of cervical trauma within 5 years prior to the onset of illness.

Our study showed muscle weakness is mainly present in the C7, C8, and T1 myotomes. Maximum weakness in the ulnar nerve innervated muscles of the hand especially abductor digiti minimi (ADM) and interossei (both dorsal and palmar), followed by abductor pollicis brevis (APB), flexor pollicis brevis and extensor digitorum. Minimal weakness was noted in the wrist flexors and extensors. Similar observations were

made by Huang YC *et al*, [36]. Some studies reported weakness of biceps, triceps and deltoid [36]. Muscle atrophy was most prominent in the hand intrinsic muscles. Oblique amyotrophy was observed in all patients (8 out of 8, 100%). Hassan KM *et al* [17] observed this in 11 out 11 patients (100%). Observed this in 67.5% and 37.5% patients respectively by Raval *et al* [16] and Sonwalkar *et al* [18]. Deep tendon reflexes except finger flexion jerk (absent in two patients) were preserved in all patients with no evidence of pyramidal tract involvement.

Minipolymyoclonus was observed in four (50%) patients in the current study. Similar observation was made by Raval *et al* [16] (in 55% patients). Studies done by Sonwalkar *et al* [18] and Hassan KM *et al* [17] observed this finding in 62.5% and 91% of patients respectively. Periscapular wasting was noted in two (25%) patients in our study. This finding was not previously described in the literature, though arm wasting was noted in 1 patient by Sonwalkar *et al* [18]. Subjective sensory symptoms (dysesthesias) were observed in various studies [16, 17, 36]. No patient reported sensory symptoms in our study.

In our study, the most obvious NCS abnormality was a reduced ulnar CMAP amplitude, observed in 5 (62.5%) cases. Low median CMAP amplitude was found in 3 (37.5%) patients. Hassan KM *et al* 17 observed low ulnar CMAP in 36% and low median CMAP in 27% patients. Reduced ulnar CMAP amplitude, was observed in two thirds (75%) of and low median CMAP amplitude in one fourth (25%) patients in a study done by Huang YC *et al*. Motor distal latency, F-latency and conduction velocity of the median and ulnar nerves were normal. Needle EMG in our patients showed denervation, in the C7, C8, and T1 myotomes (in all patients), and occasionally in the C5 and C6 myotomes (in 2 patients, 25%). Hassan KM *et al* [17] was able to observe neurogenic pattern in C7, C8 and T1 myotomes in all patients and not in C5 and C6 myotomes. Except in one patient (who had unilateral disease), all had EMG abnormalities in both upper limbs. The ulnar motor fibers were more affected than the median ones, cause for this not known.

HD is similar to MMN (multifocal motor neuropathy) with regard to its male preponderance, asymmetric distribution, distal limb involvement, and pure motor impairment. Absence of conduction block in NCS helps in differentiating this condition from MMN. Also MMN is an immune-mediated neuropathy with wider range of age of onset (from 20 to 50 years) and increased levels of serum IgM antibodies to the ganglioside GM1 in most patients. Other features which distinguish HD from MMN are younger onset age, lower limb sparing, and shorter duration of progression.

MRI with flexion contrast study is the gold standard of diagnosis of HD. Conventional radiographic studies of the cervical spine may show loss of cervical lordosis [29]. As it is not easy to retain the contrast medium in the cervical subarachnoid space when the neck is flexed myelography is difficult to perform [37]. By doing the dynamic MRI FIESTA (fast imaging employing steady-state acquisition) sequences in neutral position and flexion may obviate the need for a contrast-enhanced study [38]. The time taken for conventional and contrast-enhanced MRI was about 30–40 min, while that for the 3D-FIESTA sequence was 6 min, thereby saving the time.

Anterior shifting of posterior dural wall, Prominent epidural flow voids (suggestive of dilated epidural venous plexus), enhancing epidural crescent shaped mass, and Loss of attachment between posterior dural sac and subjacent lamina during flexion study were the most common imaging findings (in 100% cases) observed in this study. These findings were highly suggestive for the diagnosis of HD [1, 4, 29, 37, 34].

Localised cord atrophy, asymmetric cord flattening, and loss of attachment have an accuracy of 80% in identifying HD with loss of attachment as the most valuable finding for diagnosing HD [26, 34]. In our study, localised lower cervical cord atrophy, asymmetric cord flattening and loss of cervical lordosis were observed in 87.5% (7 out of 8) patients. The patient who didn't show these findings in our study had only unilateral disease. We also observed thoracic extension of epidural crescent in 50% of cases and intramedullary hyperintensity in lower cervical cord in 25% cases. Hirayama and Tokumaru [7] have reported focal cord atrophy in neutral neck position MRI in only 50% of their cases, Pradhan and Gupta observed this in 100% of their cases. Observations made by Hassan KM [17] *et al* and Raval *et al* [16] were more in conformity with our findings. Findings which were observed in > 85% patients in all the three studies (current study, Hassan KM *et al* and Raval *et al*) are - loss of cervical lordosis and asymmetric cord flattening (in neutral position MRI), loss of attachment between posterior dural sac and subjacent lamina, anterior shifting of posterior dural wall and prominent epidural crescent (in flexion position MRI). Prominent epidural crescent with contrast enhancement (during flexion MRI) was observed in 100% of cases in all the three studies mentioned above. Intramedullary hyperintensity in lower cervical cord is the least common imaging finding observed in our study (also by Hassan KM *et al* and Raval *et al*). We also observed extension of epidural crescent in to the thoracic region in 50% of cases. To ensure that this diagnosis is not missed in patients presenting with focal hand wasting, flexion contrast MRI should be done if the routine MRI otherwise looks normal.

Pradhan S *et al*, [39] observed that in normal individuals and in patients with cord atrophy due to other causes such as motor neuron disease, the cervical spinal cord moves forward during neck flexion and subarachnoid space increases behind the cord while the posterior epidural space is either not seen or is just visible. In HD spinal cord and posterior duramater move forward independently under a longitudinal stretch during neck flexion and that the forward movement of the duramater is not responsible for the cord compression. An absence of forward displacement observed by Hirayama *et al* in the later and non-progressive stage of the HD suggests that the dynamic compression has pathogenic significance [28].

Pradhan S *et al* [39] also demonstrated passive dilatation of venous channels caused by the creation of negative pressure within the enlarged epidural space in 22 of 35 patients, and opined that the flexion related hemodynamic changes in the cervical spinal cord rather than a dural pressure from behind, are responsible for the segmental degeneration of the anterior horn cells. In some severe cases they also demonstrated that the cord hits the C5-C6 vertebral body under a longitudinal stretch and gets flattened during neck flexion, so there is a possibility of pressure over the vertebral artery or its radicular branches during flexion leading to repeated mild ischemia on

the watershed zone of anterior horns.

Underlying mechanisms for venous engorgement seen on flexion studies proposed by Mukai E *et al*[26], that due the negative pressure in posterior spinal canal as a result of anterior shifting of dural canal, leading to increased flow to the posterior internal vertebral venous plexus and decrease in drainage of jugular veins impeding venous return of internal vertebral venous plexus. Also anterior internal vertebral venous plexus gets compressed by anterior displacement of dural canal increases the burden of posterior internal vertebral venous plexus leading to its distension.

Cervical collar therapy to prevent excessive neck flexion may minimize the functional disability of young patients with HD, as neck flexion contributes to the pathophysiology of this disease. Cervical collar therapy induces a premature arrest of this disease. Most beneficial in patients with shorter duration of illness and have mild cord atrophy in neutral neck position. Tokumaru and Hirayama, in 1992, reported the use of cervical collar therapy for non-progressive juvenile spinal muscular atrophy of the distal upper limb, and in 2001 Pradhan and Gupta recommended cervical collar during the acute progressive stage of the HD. Effectiveness of this treatment further emphasized by Tokumaru and Hirayama in 2001, through their observations of non - progression of illness after introduction of cervical collar in 38 cases of HD. Application of a cervical collar for 3–4 years generally has been advocated, as progressive stage is expected to cease by this time period.

In our study we advised cervical collar in all patients. After started using collar, 6 out of 8 patients who were complaint to the treatment, showed clinical improvement. In those 6 patients progression got arrested and over 6 months of follow – up showed improvement in motor power.

In selected patients other interventions like duraplasty, anterior cervical decompression and reconstructions with tendon transfers have yielded encouraging results in selected patients. Cervical duraplasty with tenting sutures via laminoplasty led to spinal cord decompression with the preservation of cervical alignment and local physiological motion in young patients [40]. This support the theory that a tight dural canal in flexion largely contributes to the pathophysiology of HD.

5. Tables and Figures

Table 1: Demographic and clinical profile

Patient	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**
Age(in years)	18	26	19	14	33	32	22	43
Sex	male	male	male	male	male	male	male	male
Duration of illness	5 months	5 years	1 year	6 months	10 years	12 years	4 months	22 years
UL wasting and weakness	Bilateral (Right > Left)	Bilateral (Left > Right)	Bilateral (Right > Left)	Unilateral (Right)	Bilateral (Right >Left)	Bilateral (Right >Left)	Bilateral (Left > Right)	Bilateral (Left > Right)
Minipolymyoclonus	absent	present	present	absent	absent	absent	present	present
Cold paresis	absent	absent	present	absent	absent	absent	absent	present
History of trauma	absent	Present	present	absent	present	absent	absent	absent

Table 2: Clinical examination findings

	Present study No (%)	**K. M. Hassan *et al* (2012) No (%)**	**Raval *et al* (2010) No (%)**	**Sonwalkar *et al*. (2008) No (%)**
Total number of patients	8	11	9	8
Hand weakness	8 (100)	11 (100)	*	8 (100)
Forearm weakness	5 (62.5)	8 (73)	*	6 (75)
Hand wasting	8(100)	11(100)	*	6(75)
Forearm wasting	8(100)	11(100)	*	4 (50)
Arm wasting	-	-	-	1 (12.5)
Periscapular wasting	2 (25)	-	-	-
Brachioradialis sparing (oblique amyotrophy)	8(100)	11(100)	6 (67.5)	3 (37.5)
Minipolymyoclonus	4 (50)	10 (91)	5 (55)	5 (62.5)
Unilateral involvement	1 (12.5)	5 (45)	8 (89)	2 (25)
Bilateral involvement	7 (87.5)	6 (55)	1 (11)	6 (75)
Brisk deep tendon reflexes	-	2 (18)	-	1 (12.5)
Cold paresis	2 (25)	4 (36)	5 (55)	-
Fasciculations	1 (12.5)	3 (27)	5 (55)	-
Hand Dysethesias	-	1 (9)	1 (11)	1 (12.5)

*mentioned as weakness and wasting in upper limb(s), right four, left four, bilateral one.

Table 3: Electrophysiological study findings

Examination	Present study No (%)	K. M. Hassan *et al* (2012) No (%)
Total number of patients	8	11
Median CMAP decreased	3 (37.5)	3 (27)
Ulnar CMAP decreased	5(62.5)	4 (36)
Sensory SNAPS	Normal	Normal
Sensory and motor CV	Normal	Normal
Distal and F latencies in median and ulnar	Normal	Normal
Fibrillations	6 (75)	5 (45)
Fasciculations	4 (50)	6 (54)
Positive sharp waves	3 (37.5)	*
Neurogenic pattern in C7,C8 and T1 myotomes	8 (100)	11 (100)
Neurogenic pattern in C5,C6 myotomes	2 (25)	-

*not mentioned.

CMAP – Compound muscle action potential, SNAP – Sensory nerve action potential, CV – conduction velocity

Table 4: MR imaging findings

	Present study No (%)	K. M. Hassan *et al* (2012) No (%)	Raval *et al* (2010) No (%)	Sonwalkar *et al*. (2008) No (%)
Total number of patients	8	11	9	8
Neutral position				
Loss of cervical lordosis	7 (87.5)	10/11 (91)	9 (100)	6 (75)
Lower cervical cord atrophy	7(87.5)	9/11 (82)	9 (100)	8 (100)
Asymmetric cord flattening	7(87.5)	11/11 (100)	9 (100)	6 (75)
Intramedullary hyperintensity in lower cervical cord	2 (25)	2/11 (18)	4 (44)	3 (37)
Flexion position				
Loss of attachment between posterior dural sac and subjacent lamina	8 (100)	9/10*(90)	9 (100)	4(50)
Anterior shifting of posterior dural wall	8 (100)	9/10(90)	9 (100)	6 (75)
Prominent epidural flow voids	8 (100)	9/10(90)	4 (44)	4 (50)
Enhancing epidural crescent shaped mass	8 (100)	10/10(100)	9 (100)	6 (75)
Thoracic extension of epidural crescent	4 (50)	**	**	**

*11 patients underwent routine neutral position MRI, 10 underwent flexion contrast MRI

**not mentioned

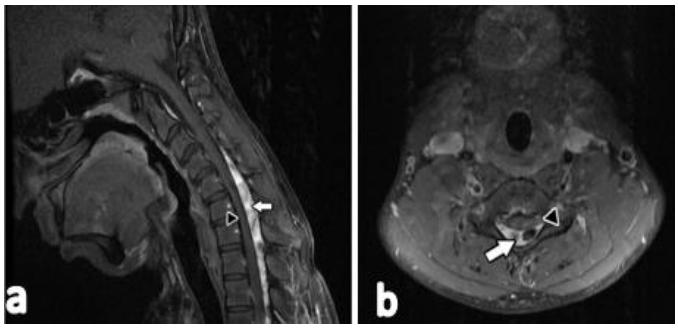

Fig 1: patient no.3 – 19 year old male with 1 year history of asymmetrical hand and forearm wasting (right > left) of 1 year duration. a) Flexion contrast MRI of cervical spine (sagittal section) showing enhancing epidural crescent shaped region (white arrow) with epidural flow voids (seen as hypodensities within the crescent) and cord atrophy (black arrow head); b) axial post contrast images of cervical spine also showing crescent region, flow voids and asymmetrical cord atrophy (black arrow head)

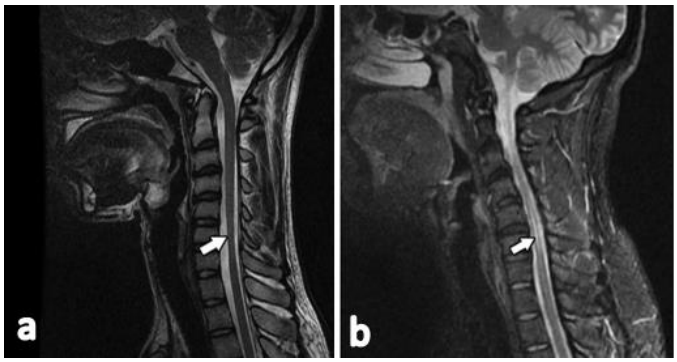

Fig 2: a) Neutral MRI cervical spine (sagittal section) of patient described in figure 1, showing loss of lordosis, and cord atrophy (white arrow); b) 22 year old male with 4 months history of asymmetrical (left > right) wasting and weakness of upper limbs with sagittal section MRI cervical spine showing intramedullary T2 hyperintensity (white arrow)

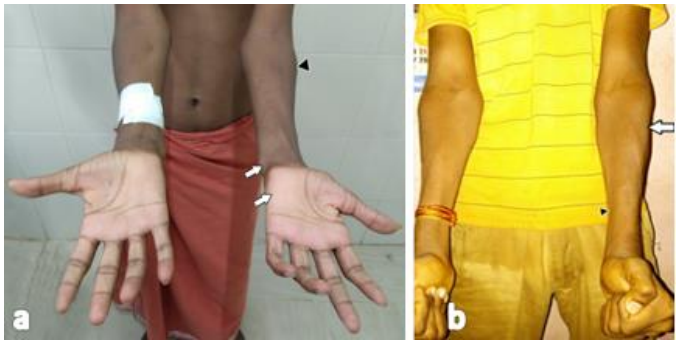

Fig 3: a) showing asymmetric distal forearm and hand wasting (left > right, denoted by white arrow), with sparing of brachioradialis (black arrow head); b) showing oblique atrophy of the forearm due to wasting of distal forearm (black arrow head) and sparing of brachioradialis (white arrow).

6. Conclusion

HD is a benign, self-limiting illness affecting young men, in the second to third decades of life. It is a pure motor syndrome with insidious onset and slowly progressive course resulting in wasting and weakness of upper limbs with sparing of brachioradialis (oblique amyotrophy). Progression of disease ceases usually after 2-4 years of symptom onset. It has got distinctive clinical and radiological features which helps in differentiating it from other diseases like MND, MMN etc. Chronic microcirculatory changes in the territory of anterior spinal artery supplying the anterior horns of the lower cervical spinal cord in those with tight dura, due to repeated neck movements is thought to be the pathophysiology. HyperIg Eaemia and trauma also may directly or indirectly contribute to the pathophysiology of HD. Though routine MRI shows features which helps in diagnosis, dynamic contrast MRI is the imaging modality of choice in diagnosing HD. So all young patients presents with pure motor syndrome of upper limbs should be evaluated for this treatable condition using dynamic contrast MRI. Early institution of treatment modalities like cervical collar alters the natural history of the disease by arresting the progression, thus helps in morbidity prevention. Though debatable avoiding competitive sport, or strenuous physical work also may help in preventing the progression as four of our patient reported trauma prior to the onset of the illness.

Acknowledgments – nil
Conflicts of interest – nil

7. References

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