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Median Cervical Corpectomy for Cervical Myelopathy Associated with Ossified Posterior Longitudinal Ligament

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ABSTRACT

Ossification of the Posterior Longitudinal Ligament (OPLL), is associated with various degree of neurological deficit. Anterior approach allows direct removal of ossified posterior longitudinal ligament through corpectomy and allows sufficient decompression of the spinal cord. The aim of the study is to evaluate the effectiveness and safety of median cervical corpectomy for management of cervical myelopathy associated with ossification of the posterior longitudinal ligament. In the period between May 2009-Aug. 2011, thirty patients were managed by median cervical corpectomy/corpectomies and bone fusion with anterior plate system fixations; in Neurosurgery Department Al-Azhar University Hospitals. They were 19 males and 11 females with the age range from 35-65 years and the mean age was 50 years. The duration of symptoms ranged from 3-36 months with the mean of 20 months. The most common complaints were paresthesia or numbness of the hands and the most common presenting signs were hyperesthesia, gait disturbance, weakness and hyperreflexia the most common type of OPLL was the mixed type in 16 patients (53.330). as regard to Magnetic Resonance Image (MRI) classifications of OPLL, the tear drop was the most common type in 15 patients (50%). Postoperative complications occurred in 7 patients (23.33%). In this study, the recovery rate by Hirabayashi formula was ranged from 25-100% with the mean 69.96±16.89%, in mixed type of OPLL the recovery rate ranged from 25-100% (Mean 65.33±17.38%), in continuous type it ranged from 42.86-100% (Mean 70.24±18.30%) and in segmental type it ranged from 71.42-100% (Mean 80.27±10.33%). Anterior corpectomy with resection of the ossified mass, followed by fusion, is a radical surgical procedure. It is best indicated for cervical spondylotic myelopathy with OPLL that extends fewer than three vertebral levels, in patient with no congenital stenosis or trauma.

Key words: Cervical myelopathy, cervical corpectomy, ossified posterior, longitudinal ligament, spine fusion

INTRODUCTION

Ossification of the Posterior Longitudinal Ligament (OPLL) is a hyperostotic progression of the Posterior Longitudinal Ligament (PLL) that is associated with various degrees of neurological deficit. OPLL was considered specific to Asians, however it is recognized as a subtype of diffuse idiopathic skeletal hyperostosis. Patients have various degrees of neurological deficits; however the thickness or progression of ossification is not always proportional with the degree of neurological disorder (Yang, 2007).

Cord compression involves both of the mid -vertebral as well as to the vertebral endplate levels. Good decompression and outcome are difficult to obtained with anterior discectomy performed through the disc space (Mizuno and Nakagawa, 2001).

Precise radiological evaluation leads to correct diagnosis and treatment. In Plain X ray films, the symptomatic myelopathy increase with canal diameter less than 10 mm, while in the relative cervical stenosis the canal diameter between 10-13 mm. When the "occupation ratio" is greater than 40% as defined by the thickness of OPLL divided by the canal diameter more severe deficits appear earlier. However in Magnetic Resonance Imaging (MRI) early OPLL appears slightly hyperintense on MRI without contrast administration and is enhanced homogeneously with Gadolinium Diethylenetriamine penta acetic acid. Compared with disc herniation, which are uniformly hypointense, mature OPLL appears densely hypointense on both T1- and T2-weighted images (Epstein, 2002). Three patterns of dural ossifications of posterior longitudinal ligaments: isolated, double layer and en block type (Mizuno *et al*., 2005).

In Computed Tomography (CT) evaluations, early OPLL may contain punctate or pearls of ossification and these centers will progressively coalesce as maturation occurs. The four types of OPLL include: the segmental form, the continuous form, the mixed form and localized form (Epstein, 2002).

Laminectomy was previously performed for extensive ossification but laminoplasty is conducted to preserve posterior support for the spinal column and to prevent postoperative kyphosis. Anterior decompression and fusion are performed too (Matsunaga *et al*., 2004).

Sufficient decompression of the spinal cord will not be obtained with surgeries from the posterior approach (Fujiyoshi *et al*., 2008). So anterior approach should allow direct removal of OPLL compressing the spinal cord to achieve good outcomes (Mizuno and Nakagawa, 2001).

The Aim of the study is to evaluate the effectiveness and safety of median cervical corpectomy for management of cervical myelopathy associated with ossification of the posterior longitudinal ligament.

MATERIALS AND METHODS

This prospective study conducted on 30 patients with cervical myelopathy associated with OPLL managed by median cervical corpectomy in neurosurgery department, Al-Azhar university hospital through the duration from May 2009 to August 2011.

Inclusion criteria: Cervical Spondylotic Myelopathy (CSM) associated with OPLL involving the cervical spine from C3-C7.

Exclusion criteria: Previous cervical spine surgery, fractured cervical spine; patients with poor motor power (grade 2 or less). All the cases were subjected to the following management schedule: Detailed history taking, Full general and neurological examination, Complete radiological evaluation by plain x-ray cervical spine (AP and Lateral), cervical CT with 3-D reconstruction and MRI, Operative preparation. Surgical procedure Follow up, clinical and radiological.

Examination: General examination: The patients look: normal, debilitated, toxic or others. Vital signs: Pulse, Blood Pressure (BP), Respiratory Rate (RR) and Temperature. Indirect laryngoscopy the day before surgery by specialist of otolaryngologist must be done to assess the vocal cords.

Neurological examination including: Cranial examination: Spinal examination: Inspection, Palpation and Dynamic examination Motor power, Muscle tone and Sensory (Superficial and Deep) reflexes. Benzel modification of Japanese Orthopedics Association Score (BmJOA) for all patients.

Routine laboratory works up

Radiological studies: Plain X-ray Anteroposterior (A-P) and lateral views; CT cervical spine with three D reconstruction and MRI cervical study were carried out to all patients:

Data to be obtained from radiological studies:

- Cervical curve using regional angle and local Cobb's angle
- Types of OPLL
- Types of any associated disc prolapse (central or postero-lateral, far lateral, or foraminal)
- Associated dural ossification (DO) or ossification of ligamentum flavum (OLF)
- Signal changes of the cervical cord

Follow up

Clinical: All patients undergo general and neurological evaluation monthly for six months postoperative:

- Monthly recorded of BmJOA scores for six months duration
- Recovery rates were done for all patients by Hirabayashi formula 6 months post-op

$$\text{Recovery rate } (\%) = \frac{\text{Post-op score-pre-op score}}{\text{18 (total score)-pre-op score}} \times 100$$

Radiological: Plain x-ray and CT three D reconstructions and MRI study after six months postoperatively.

Plain x-ray and CT three D reconstructions and MRI study after six months postoperatively.

Statistical analysis: All data were stored on a personal computer and analyzed using commercially available statistical software (SPSS version 16.0, SPSS Inc.). Chi-Square analyzing was used to compare categorical data (qualitative). The student t-test was applied to compare quantitative data significance was judged at a value of $p<0.05$ for all analyses.

RESULTS

This study included 30 patients with cervical spondylotic myelopathy associated with OPLL treated by anterior cervical corpectomy/corpectomies and bone fusion (ACCF) with anterior plate system fixation. There was 19 males (63.33%) and 11 females (36.66%) with female to male ratio 1:1.73. The age of the patients ranged from 35-65 years with greatest incidence was in the 5th decade of life. The mean age was 48.93 years. The duration of symptoms in the studied patients ranged from 3-36 months with mean duration of 12±10.11 months. The most common presenting complaint of the patients were paresthesia or numbness of the hands, sphincteric dysfunction and difficulty in walking that were found in all patients (100%). Motor dysfunction was also present on all patients. (Table 1). Pre-op Bm JOA scores were ranged from 4-17 with the mean 11.43±2.56. Incontinuous type of OPLL, pre-op Bm JOA scores were ranged from 8-15 with the Mean 11.57±2.44. In segmental type of OPLL, pre-op Bm JOA scores were ranged from 9-17 with the Mean 14.14±2.41. In mixed type of OPLL, pre-op Bm JOAscores were ranged from 4-14 with the Mean 11.06±2.74.

Table 1: Most common presenting symptoms in this study

Symptom	No. of patients	Percentage
Paresthesia or numbness of the hands	30	100.00
Sphincteric dysfunction	30	100.00
Dif?culty in walking	30	100.00
Hand and fingers clumsiness	27	90.00
Axial pain (neck pain)	26	86.66
Stiff spine	18	60.00
Tightness of the trunk or legs	16	53.33

Table 2: Most common signs in this study

Sign	No. of patients	Percentage
Hyperthesia	30	100.00
Gait disturbance	30	100.00
Weakness	30	100.00
Hyperreflexia	29	96.66
Hoffman sign	29	96.66
Inverted brachioradialis reflex (IBR)	25	83.33
L'hermitte's Sign	23	76.66
Sustained patellar clonus	22	73.33
Sustained ankle clonus	22	73.33
Babinski sign	17	56.66
Spurling sign	4	13.33
Unsustained patellar clonus	2	6.66
Unsustained ankle clonus	1	3.33

++: Normoreflexia, +++: Hyperreflexia

Pre-op Bm JOA scores difference between continuous, segmental and localized types of OPLL was insignificant p value of 0.654.

In this study, pre-op Nurick grading were ranged from 2-5 with the Mean 3.23±0.68. Pre-op Nurick grading difference between continuous, segmental and mixed types of OPLL was insignificant p value of 0.454.

In continuous type of OPLL, the mean of pre-op Nurick grading was 3.14±0.69. In segmental type of OPLL, the mean of pre-op Nurick grading was 3.00±0.58. In mixed type of OPLL, the mean of pre-op Nurick grading was 3.38±0.72.

The most common presenting sign of the patients was hyperthesia, gait disturbance and weakness that were found in 30 patients (100%). The second most common sign was hyperreflexia that was found in 29 patients (96.66%) (Table 2).

The most common type of OPLL found in this study was the mixed type 16 patients (53.33%), followed by both continuous in 7 patients (23.33%) and segmental type in 7 patients (23.33%). There was no patient with localized type of OPLL.

By axial MRI and CT, in this study, OPLL were classified into 3 types; triangular, teardrop and boomerang configurations of their spinal cords. The tear drop type was in 15 patients (50.00%), triangular type was in 10 patients (33.33%) and boomerang type was in 5 patients (16.67%).

In this study, the recovery rate by Hirabayashi formula was ranged from 25-100% with the mean 69.96±16.89%.

The recovery rate in single level corpectomy ranged from 50-100% (Mean 74.90%), in two-levels corpectomies ranged from 25-85.71% (Mean 62.85%), while in three-levels corpectomies (only one patient) 83.33%.

Signal hyperintensity T2-weighted changes of the spinal cord were correlated with the more severe neurological deficit (20 patients 66.66%). The pre-op Bm JOA of those patients were the worst (4/18-11/18).

Operative finding: All patients (30 patients, 100%) were operated by ACCF and plating. All patients were operated in supine position with mild neck extension. The duration of surgery ranged from 110-210 min with the mean 157±27.62 min The volume of intraoperative blood loss ranged from 400-1100 cc with mean of 530 cc. Eighteen 1 patients (60%) needed intraoperative transfusion of 1 unit of blood and 3 patients (10%) need Intraoperative transfusion of 2 units of blood.

In this study, C4 was involved in the corpectomy/ies of 12 patients (49%), C5 was involved in the corpectomy/ies of 19 patients (63.3%) and while C6 was involved in the corpectomy/ies of 14 patients (46.7%). The average number of vertebral bodies involved is 1.5. One level corpectomy was done in 16 patients (53.33%), 2 level-corpectomies in 13 patients (43.33%) and only in one patient (3.33%) 3 level corpectomies was done.

Nurick classification was done preoperative and six months later. The best preoperative Nurick grade was 2 and the worst was 5 (mean 2.33), while the best post-operative Nurick grade was 0 and the worst was 4 (Mean 0.73). The best improvement was 3 degrees and the worst was one degree improvement. There were no patient with deterioration in Nurick grading (mean degree of improvement is 2.5 grade up).

Difference in improvement in Bm JOA in continuous, segmental and mixed types of OPLL was insignificant p value of 0.70. Improvement in Nurick grading in this study ranged from 0-100% with mean of -76.83±25.44%.

Improvement in Nurick grading difference between continuous, segmental and mixed types of OPLL was insignificant p-value of 0.666.

Postoperative complications: Postoperative complications occurred in 7 patients (23.33%). And includes temporary dysphagia in 5 patients (16.66%) and disappeared in 2-5 days post-operative, motor weakness in 2 patients (6.66), donor site infections in 4 patients (66.6%) (Table 3).

Pre and post-operative cervical regional and Cobb angle in neutral position were measured. Pre-op Regional cervical angle ranged from 2-20 degrees (Mean 7.70±4.53) while post-op Regional cervical angle ranged from 7-25 degrees (Mean 13.63±4.85). Pre-op Cobb's angle ranged from 3-18 degrees (mean 9.63±3.66), while the post-op Cobb's angle ranged from 1-25 degrees (Mean 16.20±5.31).

Table 3: Incidence of complications in the current study

Complication	No. of patients	Percentage
Motor power deterioration	2	6.66
Donor site infection	4	13.33
Cervical wound infection	1	3.33
Temporary dysphagia	5	16.66
Permanent dysphagia	0	0.00
Cerebro-spinal fluids (CSF) leak	0	0.00
Plate problem (screw pullout)	1	3.33
Graft displacement	1	3.33

Radiological follow up included plain X-ray, CT and magnetic resonance image: Plain X-rays follow up were accepted in all patients except for one patient after 2 months which showed pulled out screws and plate was elevated from the body of the vertebra above (C3). The recovery rate for him was 25% after the primary surgery and still the same (25%) after the second operation.

CT was done after 6 months to all patients. The decompression was evident in all patients with successful bony fusion. MRI was done in the 6 months follow up period and demonstrated a regression or stationary in the postoperative expansion of the high signal intensity area of the spinal cord.

In this study, there was a positive correlation between the postoperative high signal intensity area of the cord and neurologic outcome. A decrease in the extent of expansion of the high signal intensity area was found in 25 patients (83.33%) with recovery outcome rate ranged from 60-100%. It was stationary in 5 patients (16.67%) with recovery outcome rate ranged from 25-50% (Mean 40.18%).

Neurological improvement rates in anterior approaches to cervical OPLL are summarized in (Table 4). Improvement rates varied from 51-71.7%. There are many varieties of techniques, bone grafts and instrumentations for anterior approach surgery.

The most common presenting complaint of the patients were paresthesia or numbness of the hands, sphincteric dysfunction and difficulty in walking that were found in all patients (100%).

The most common presenting sign was hyperthesia, gait disturbance and weakness which found in 30 patients (100%) followed by hyperreflexia that was found in 29 patients (96.66%).

Table 4: Summary of outcomes for anterior approach surgery in cervical OPLL

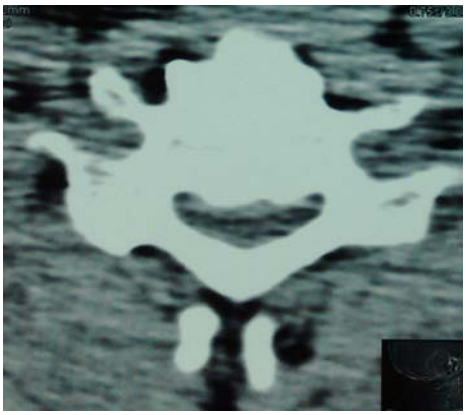
Study	No. of patients	Mean improvement rate	Notes
Mizuno and Nakagawa (2001)	107	Not described	Excellent or good outcome 89%
Onari *et al*. (2001)	30	Not described	Patients underwent anterior interbody fusion with decompression; 24 patients improved in functional score
Goel and Pareikh (2005)	4	Not described	Patients underwent oblique corpectomy; all patients showed clinical improvement
Rajshekhar and Kumar (2005)	12	Not described	Study in poor-grade patients (Nurick Grades 4 & 5); 76% improvement in Nurick grade
Nakase *et al*. (2006)	12	67.4%	None available
Chacko and Daniel (2007)	3	Not described	Patients with combined OALL and OPLL who underwent oblique corpectomy; all patients showed clinical improvement
Iwasaki *et al*. (2007)	27	51%	Study in patients w/OPLL who underwent ant decompression and fusion
Chen *et al*. (2009)	19	63.2%	Study in patients w/severe OPLL w/preop CT scans showed narrowing rate 50-78%
Kim *et al*. (2009)	17	71.7%	Anterior fusion w/autologous bone grafts from vertebral bodies and bioabsorptive screws (Williams-Isu method)
Ozer *et al*. (2009)	15	Mean JOA score improved from 9.0-12.7	Study in patients who underwent open-window corpectomy
Dalbayrak *et al*. (2010)	29	Mean JOA score improved from 13.44-16.16	Patients with CSM or OPLL who underwent skip corpectomy

(a)

Anteroposterior

Lateral

(b)

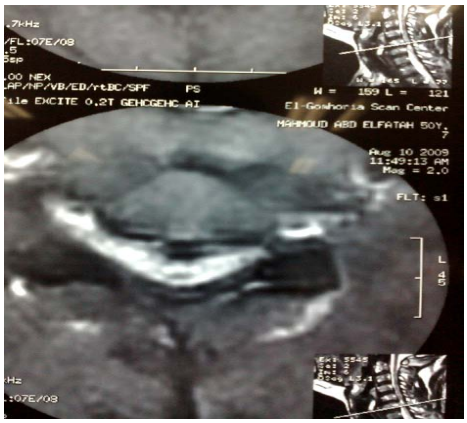


Axial

Sagittal reconstruction

(c)

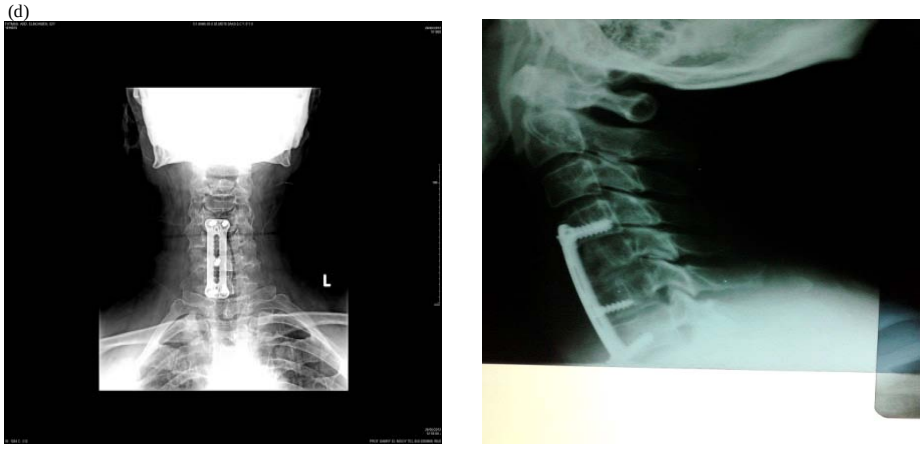
Sagittal T2 WI



Axial T2

Fig. 1(a-e): Continue

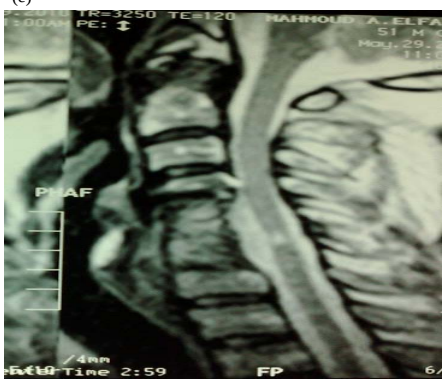
(d)



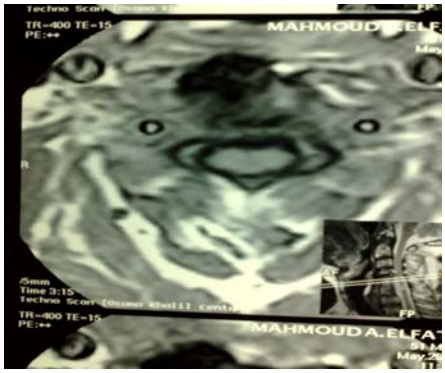
Anteroposterior

Lateral

(e)



Sagittal MRI T-2 weighted image shows decompressed cord and fading of the signal changes in the cord



Axial MRI T-2 weighted image shows decompression and widening of the neural canal

Fig. 1(a-e): Plain x-ray cervical spine antropesterior and lateral view demonstrated spondylotic changes with multiple ostephyte formation and narrowed (a) C 5-6, C6-7 spaces, (b) CT scan demonstrating segmental type of OPPL opposite C5 and C6 (c) MRI sagittal T2 WI and axial T2 WI shows large diffuse posterior prolapsed C5-6 markedly compressed cord and both related nerve roots (d) post-operative plain x ray AP and lateral view with internal fixation by plate from C4 to C7 and (e) post operative MRI axial and saggital T2 WI after 6 months shows decompressed cord and widening of the neural canal

Pre-operative radiological studies

Pre-operative radiological images: This is a male patient 50 years old was found to have cervical spondylotic myelopathy and OPLL Fig. 1a: Plain X-ray cervical spine A-P, lateral demonstrating spondylotic changes with multiple osteophytes formation and narrowed C5-6 and C6-7 spaces.

DISCUSSION

Cord compression involves both of the mid-vertebral as well as to the vertebral endplate levels. Therefore, anterior discectomy performed through the disc spaces fails to yield a good decompression and subsequently outcome (Mizuno and Nakagawa, 2001).

In this study, there were 19 males (63.33%) and 11 females (36.66%) with female to male ratio 1:1.73 In accordance with this current study, Maeda *et al.* (2001) and Kaneko (2006) found a female/male ratio of 1:2. Wu *et al.* (2011) found that about 2-fold higher risk of OPLL in men more than in women with incidence female to male ratio 1:2.65.

In this study, the age of the patients ranged from 35-65 years (Mean 48.93±7.89 years). Taketomi (1997) found that the age of symptomatic patients ranged from 27-78 years (Mean 54.5 years). In the study of Kaneko (2006), the average age at the onset of symptoms was about 50 years, While in Saetia *et al.* (2011), it was in the 5-6th decade of life. Wu *et al.* (2011), found that the incidence of myelopathy with OPLL increased by a rate of 80% for every 10-year increase in age.

Epstein (2002) found that the segmental types occurs in most cases (39%), In Tanaka *et al.* (2006) reported that the segmental type is the most common (39%). Rhee *et al.* (2009) and Nagata and Sato (2006), found the same that segmental type was 39% of patients with cervical OPLL. The continuous, mixed and localized types occurred in 27, 29 and 7%, respectively. While in Kalb *et al.* (2011) found that the segmental type occurs in most cases also (36.4%) followed by localized types (27.3%), the mixed (21.1%), continuous (15.2%).

In this study, C4 was involved in 12 patients (49%), C5 was involved in 19 patients (63.3%), while C6 was involved in 14 patients (46.7%). The average number of vertebral bodies involved is 1.5. This number is less than other series as (Nagata and Sato, 2006). This may be due to the small number of the sample in this study or due to the extensive disease in Japanese people than Egyptians but this need more epidemiological studies for further explanation. They detected cervical OPLL (in order of frequency) at levels C4 (68%), C5 (49%) and C6 (44%). The average number of vertebral bodies involved is 3.1 (Nagata and Sato 2006). Involvement of two levels was the most common and always included C5 and C6. The most affected levels by both disc herniation and spondylosis are C6-C7disc, followed by C5-C6 disc (Shedid and Benzel, 2007).

Dalbayrak *et al.* (2010) found that the mean JOA score was 13.44 and Ozer *et al.* (2009), it was 12.7. These figures were near the mean of the current study. In this study pre-op Bm JOA scores were ranged from 4-17 (Mean 11.43±2.56) In continuous type of OPLL, pre-op Bm JOA scores were ranged from 8-15 (Mean 11.57±2.44). In segmental type, they were ranged from 9-17 (Mean 14.14±2.41). In mixed type they were ranged from 4-14 with the mean 11.06±2.74. Pre-op Bm JOA scores difference between continuous, segmental and localized types of OPLL was insignificant p value of 0.654.

Pre-op Bm JOA scores difference between boomerang, teardrop and triangular types of OPLL was insignificant p value of 0.988. Rajshekhar and Kumar (2005) found that Nurick Grade ranged from 4-5, with the mean 4.11.Agrawal *et al.* (2004), demonstrated the Nurick Grade ranged from 3-5 with the mean 3.34. In this study, pre-op Nurick grading was ranged from 2-5 with the mean 3.23±0.68. Pre-op Nurick grading difference between continuous, segmental and mixed types of OPLL was insignificant (p-value of 0.454) and this is in accordance with (Rajshekhar and Kumar, 2005) and also with Agrawal *et al.* (2004).

The duration of symptoms in the studied patients ranged from 3-36 months (Mean 12±10.11 months). In accordance with Hoh *et al.* (2011), the patients of this study presented by axial pain (neck pain), followed by tightness of the trunk or legs and lastly sphincteric dysfunctions, difficulty of walking and weakness. The axial discomfort may originate from stimulation of the sinuvertebral nerve spreading in the posterior longitudinal ligament or constriction of the nerve root in the canal; however, the exact origin remains unclear (Kaneko, 2006).

The most common presenting complaint of the patients were paresthesia or numbness of the hands, sphincters dysfunction and difficulty in walking that were found in all patients (100%). Motor dysfunction was also present on all patients. The second most common complaint was clumsiness of the fingers that was found in 27 patients (90%). Other clinical manifestation were axial pain (neck pain in 26 patients (86.66%), quadriparesis (83.33%), stiff spine in 18 patients (60%), tightness of the trunk or legs in 16 patients (53.33%), upper limb weakness only (16.67%). The incidence of symptoms and signs did not gain statistical value. Kaneko (2006) found that the symptoms were neck pain in 69% of patients, numbness of the upper limbs in 67%, motor weakness/clumsiness of the upper limbs in 42%. The incidence of symptoms in this study was higher than that of Kaneko. This may be explained by the late presentation of the patients to seek the proper medical advice.

As regard to myelopathy, the comparison with others is of a little value because myelopathy must be present in all the studied patients as an inclusion criterion. Others had different inclusion criteria, so Matsunaga *et al.* (2004), reported that only about 40% of OPLL symptomatic patients presented with myelopathy compared to 20-50% in the study of Epstein (1997).

According to Tsuyama (1984), no specific symptoms and signs of cervical OPLL are reported. Approximate 45% of patients with cervical OPLL have some neurological symptoms, About 45% of patients with OPLL have motor dysfunction of the extremities and 16.8% of patients need help with their activities of daily living; 5% of patients have no symptoms (Tsuyama, 1984). Another nationwide survey in Japan done by Terayama, 1976 reported that pain/numbness of the upper limb was 74%, neck pain was 64%, changes of reflexes in the lower limbs were 58%, sensory chanes in the upper limbs were 55% and changes of reflexes were the upper limbs 52%.

The most common presenting sign of the patients was hyperthesia, gait disturbance and weakness that were found in all patients. The second most common sign was hyperreflexia that was found in 29 patients (96.66%).

Rhee *et al.* (2009) stated that the manifestations of cord signal changes or myelomalacia are significant in diagnosis, especially Hoffman, clonus, hyperreflexia of the biceps, triceps and brachioradialis.

No significant differences are present in the prevalence of Inverted Brachioradialis Reflex (IBR), Babinski, or patellar and Achilles reflexes.

Kaneko (2006) found that changes in reflexes (biceps and triceps tendon reflexes) existed in 59% (hyperreflexia 52%, hyporeflexia 7%), positive Hoffman's reflex in 41% and sensory change in 56%. Those in the lower limbs were hyperreflexia of the patellar or ankle tendon reflexes (or both) in 57%, positive Babinski's reflex in 25% and sensory changes in 37%. There was a distinct difference in the laterality in 27% of patients. Plain radiography is the simplest method for detecting OPLL but it has some limitations. Chang *et al.* (2010) reported low inter and intra observer reliability of lateral radiography, as a tool for OPLL classifications. They emphasized the importance of CT with 3D reconstructed images to overcome this problem. This was in agreement with the current study as CT was used as a crucial tool for diagnosis. Evaluation of regional cervical angle and Cobb's angle was done using both X-rays and mid sagittal CT. Computed tomography and/or myelography are useful tools for detecting and accurately locating OPLL (Saetia *et al.*, 2011). In Mizuno and Nakagawa (2001) retrospectively found that bone window CT scans were the most useful method for detecting dural ossification, whereas MR imaging was ineffective in recognizing dural ossification. Computed Tomography (CT) is exquisitely sensitive to ligamentous ossification and calcification and it represents a "gold standard" in the diagnosis of OPLL.

These considerations about X-ray and CT in diagnosis of patients in the current study were in accordance with Mizuno *et al.* (2005), Tanaka *et al.* (2006) and Saetia *et al.* (2011).

By using the axial MRI and CT, in this study, OPLL was categorized into 3 types; triangular, teardrop and boomerang configurations as used by Matsuyama *et al.* (2004). The tear drop type was detected in 15 patients (50.00%), triangular type was in 10 patients (33.33%) and boomerang type was in 5 patients (16.67%). In Matsuyama *et al.* (2004) found out tear drop type in 13 patients (29.54%), triangular type in 10 patients (22.73%) boomerang type in 21 patients (47.73%).

MRI was done in the current study to assess the associated disc prolapse and cord signal changes but it was less sensitive for ossification and calcification. This is in accordance with Tanaka *et al.* (2006) who found that MRI is less sensitive and less specific for the diagnosis of a small ossified or calcified mass. Its principal use is in the assessment of associated cord compression and intramedullary cord lesions such as cord edema and myelomalacia.

In MRI of the current studied patients, a characteristic OPLL, signal hypointensity on both T1 and T2-weighted MR imaging were found in all patients. MR imaging was helpful for determining the actual level of spinal cord compression and for suggesting the optimal method of surgical treatment. Signal hyperintensity T2-weighted changes of the spinal cord were correlated with more severe neurological deficit (20 patients 66.66%).The pre-op Bm JOA of those patients were the worst (4/18-11/18). This was in accordance of the studies of Koyanagi *et al.* (1998) and Saetia *et al.* (2011).

In this study ACCF associated with anterior cervical fixation system were done with removal of the OPLL in most cases (83.33%), however in 5 cases the ossified ligaments were adherent to the dura, so floating method of freeing the edges of the ligament were done to avoid the risk of dural tear, cord injury or CSF leakage. All the five cases were of continuous type of OPLL. Three of them were boomerang type and two were of triangular type. So it is recommended to take more care during resection of the continuous type of OPLL. One level corpectomy was done in 16 patients (53.33%), 2 levels corpectomies in 13 patients (43.33%) and only in one patient (3.33%) 3 levels corpectomies was done.

A high degree of localized, continuous, or mixed type narrowing, where the results of posterior decompression are questionable, constitutes an absolute indication for anterior decompression, preferably by the anterior floating method. The floating method of removal of OPLL described by Yamaura *et al.* (1999). It involves thinning and releasing the ossification, which results in massive anterior floatation. Transverse decompression includes the lateral bony protuberance and generally extends more than side to side 20 mm to avoid residual ossification to prevent insufficient floating of the ossification (Shinomiya *et al.*, 2006).

In this study, the recovery rate by Hirabayashi formula was ranged from 25% to 100% (mean 69.96±16.89%).This was in accordance with many studies done from 2006-2010; (Nakase *et al.*, 2006) found that mean improvement rate was 67.4% (12 patients), while in Iwasaki *et al.* (2006) it was 51% (27 patients), in Chen *et al.* (2009) it was 63.2% (19 patients), in Kim *et al.* (2009) it was 71.7% (17 patients) and in Dalbayrak *et al.* (2010) it was 59.65% (29 patients).

In this study the difference in improvement in Bm JOA in continuous, segmental and mixed types of OPLL was insignificant (p value = 0.70). In continuous type of OPLL, the mean of improvement in Bm JOA was 40.72±23.32%. In segmental type, the mean of improvement was 40.24±22.52%. In mixed type, the improvement was 96.69±2.41%.

The recovery rate difference between boomerang, teardrop and triangular types of OPLL was insignificant (p-value = 0.458). In contrast to the study of Matsuyama *et al.* (2004), they found that

the recovery rate were the worst for those with triangular (23%), intermediate for those with boomerang (61.8%) and the best for those with teardrop shapes (72.1%). This is may be due to the difference in percentage of each type between their study and the current study, especially in boomerang type which was found in 5/30 patients only in comparison to 21/44 in Matsuyama *et al.* (2004).

In this study, post op Nurick grading were ranged from 4 to 0 with (Mean 0.83±0.99). Improvement in Nurick grading in this study ranged from 0 to -100.00% (mean = 76.83±25.44%). Improvement in Nurick grading difference between continuous, segmental and mixed types of OPLL was insignificant (p-value of 0.666).

Improvement in Nurick grading difference between boomerang, teardrop and triangular types of OPLL was insignificant (p-value of 0.604). In the current study radiological follow up demonstrated that plain X-ray that used especially in the early post-op period, to evaluate the bone graft and the anterior fixation system was accepted in all patients except for one patient (3.3%). After 2 weeks of surgery and during an epileptic fit (known epileptic taking AEDs), screws were pulled out and plate was elevated from the body of the vertebra above (C3) and the patient had been reoperated again. The first operation was ACCF, corpectomies of C4 and C5, iliac bone graft and fixation 2 screws in both C3 and C6 with one screw in the graft.It showed pulled out screws and the plate had been elevated from the body of the vertebra above (C3). The recovery rate for him was 25% after the primary surgery and still the same (25%) after the second operation.

CT done 6 months for all patients showed adequate decompression evident in all patients with successful bony fusion.

MRI was done in the 6 months follow up period and demonstrated a regression or stationary in the postoperative expansion of the high signal intensity area of the spinal cord. A decrease in the extent of expansion of the high signal intensity area was found in 25 patients (83.33%) with recovery outcome rate ranged from 60-100% (mean 75.53%). It was stationary in 5 patients (16.67%) with recovery outcome rate ranged from 25-50% (mean 40.18%).

The same correlation was also reported by Yagi *et al.* (2010) who demonstrated a positive correlation between postoperative expansion of the high signal intensity area of the spinal cord and poor neurological outcomes of patients with cervical OPLL.

In the anterior median cervical corpectomy, it has been reported an overall complications of 24% including cerebrospinal fluid leakage, motor power deterioration, cervical wound or donor site infections and pseudarthrosis with or without dislodgement the grafted bone. Salvage operation was required was 12.5% (Toyama *et al.*, 1997).

The overall complications were detected in 23.33% in this series. Motor power deterioration had occurred in 2 patients (12.5%, insignificant p value: 0.39). Both of them had mixed type of OPLL, one had boomerang type (20%) while the other patient had a triangular type (10%) (insignificant p-value: 0.262). There was only one patient (6.2%) with cervical wound infection.

Temporary dysphagia was reported in five patients in this study relieved after 2-4 days. Oral feeding was not interrupted and no need for nasogastric tube feeding. Hot drinks only were used with no specific medications. Temporary dysphagia occurred in 16.7% of the patients, one in the single corpectomy group = 6.2% (insignificant p value: 0.036), three in double corpectomies group = 23.1% (insignificant p-value: 0.064) and one in the triple corpectomy patient = 100% (insignificant p-value: 1).

Fortunately, there was no case complicated by CSF leakage in this study; however, in Mizuno and Nakagawa (2001) reported a 20% incidence of CSF leak. Cervical dural tears and CSF

leaks after anterior decompression procedures has ranged from 0.5-3%. For OPLL (including the floating method also) it was much higher, ranging from 4.3-32% (Mazur *et al*., 2011).The incidence in the study of Cardoso *et al*. (2011) was between 6.7 and 31.8%. It increased from 5.6 and 5.3% for a 1 and 2-level corpectomy, respectively, to 16.7% for a 3-level corpectomy (Cardoso *et al*., 2011).

CONCLUSION

Anterior corpectomy with resection or floating of the ossified mass followed by fusion is a radical surgical procedure best indicated for cervical spondylotic myelopathy with OPLL that extends fewer than three vertebral levels below C-3 and above C-7 in a patient with no congenital stenosis or cervical spine trauma.

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