Original Article

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Surgical Outcomes in Patients Operated for Cervical Myelopathy using Japanese Orthopaedic Association Cervical Myelopathy Evaluation Questionnaire

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Abstract

Study Design: This was a retrospective case series.

Objective: The objective of the study was to assess the surgical outcomes of patients with cervical myelopathy, using the Japanese Orthopaedic Association Cervical Myelopathy Evaluation Questionnaire (JOACMEQ).

Summary of Background Data: Degenerative cervical myelopathy (DCM) is a leading cause of morbidity. Patients present with spasticity, gait imbalance, and loss of fine motor function. Most patients present early; however, few manage with disability for years and present late.

Methods: Fifty-two consecutive patients underwent surgery for cervical myelopathy from 2008 to 2013; however, detailed follow-up was available in only 42 patients. Thirty-nine patients were ambulatory, while 3 were non-ambulatory at the outset. Nineteen patients underwent anterior surgery and 23 patients underwent posterior surgery. Frankel, Nurick grades, Neck Disability Index (NDI), and JOACMEQ scores were recorded at time of admission, 6, 12, 24, and 52 weeks, and then annually. Outcomes at final follow-up were included for statistical analysis.

Results: Thirty-four (81%) patients improved, 4 (9.5%) patients remained static, and 4 (9.5%) patients worsened according to Nurick scale. Nurick grades improved from 3.52 to 1.64. Mean NDI scores improved from 42.28 to 20.28. Analyzing the JOACMEQ scores, cervical spine function improved in 15 (35.7%), upper extremity (UE) function improved in 33 (78.6%) patients, while lower extremity (LE) function improved in 32 (76.2%) patients. Bladder function improved in 17 (40.47%). Quality of life improved in 37 (88.1%) patients. LE improved more than UE, in the younger (<45 years) group, and in those with subaxial myelopathy. Pre-operative symptoms greater than 12 months had a negative impact on outcome. Pre-operative neurology, approach, and instrumentation did not impact outcomes. Four (9.5%) patients developed major neurological deficit, 4 (9.5%) patients had C5 deltoid palsy, while 1 patient had recurrent laryngeal palsy.

Conclusion: Surgical results of DCM are highly satisfactory, even in late cases. LE improved more than UE in subaxial cases and in younger individuals. Surgical intervention within 12 months of symptoms affects outcome positively.

Keywords: Degenerative cervical myelopathy; Cervical spondylotic myelopathy; Surgical outcomes; JOA scores, JOACMEQ scores, ossified posterior longitudinal ligament; Cervical discectomy; Cervical laminectomy; Iliac crest bone graft; Anterior cervical discectomy and fusion; Artificial cervical disc replacement; Lateral mass screws.

Introduction

Degenerative cervical myelopathy (DCM) has been recognized, the world over, as a leading cause of morbidity, especially, in those aged more than 55 years [1]. Despite the vast majority of patients suffering from subclinical myelopathy, few are recognized early. Part of the delay in diagnosis is due to the ignorance about this condition in the medical community, whereas a smaller subset of patients with limited disability

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prefers to postpone definitive surgical management, due to the fear of post-surgical neurological catastrophe. Most patients present with significant spasticity, gait imbalance, and loss of fine motor and hand function.

Methods

All consecutive patients exhibiting evidence of cervical myelopathy, due to degenerative cervical disease or ossified posterior longitudinal ligament (OPLL), and undergoing surgical management were included in the study. Any patient with pre-existing myelopathy, with an associated acute traumatic deterioration, was excluded from the study. Similarly, patients presenting with myelopathy due to rheumatoid arthritis or atlantoaxial subluxation were excluded from the study. Fifty-two patients underwent surgery, during the period from January 2008 to December 2013; however, detailed follow-up was available in only 42 of these patients. Mean age of these patients was 53.8 (38–75) years. Thirty-nine of 42 patients were ambulatory, either by support or independent, while three were non-ambulatory at the time of surgery. Patients having single- or two-level disease were approached anteriorly, whereas all patients with three or more levels of involvement were treated using a posterior approach. All patients with a kyphotic alignment as well as OPLL underwent additional supplementary posterior stabilization.

Frankel and Nurick grades, Neck Disability Index (NDI), and Japanese Orthopaedic Association Cervical Myelopathy Evaluation Questionnaire (JOACMEQ) scores were recorded at time of admission for surgery.

Anterior cervical discectomy/corpectomy and fusion (ACDF/ACCF) was performed in 19 patients. Twenty-three patients underwent posterior cervical decompression, either by laminoplasty or laminectomy, with or without fusion.

Patients were followed up at 6, 12, 24, and 52 weeks and then annually. All functional outcomes, along with Frankel and Nurick grades, were documented, either in person or by telephone. All post-operative interviews were taken by personnel not involved in the surgical management. All outcomes at final follow-up were included for statistical analysis.

Results

Forty-two patients underwent either anterior or posterior surgery for cervical myelopathy. Thirty-six patients had classic degenerative cervical myelopathy, whereas six patients had OPLL. Most patients presented within a few days, while some presented as late as 7 years following onset of symptoms. Mean duration from onset of symptoms to surgery was 13 months (1 month–84 months); however, the median was noted to be 6 months.

Of these 42 patients, 37 were male and 5 were female. Mean age of these patients was 53.8 years (38–75).

Table 1: Primary data regarding type of procedure

Anterior	Disc (ACDF)	Corpectomy (ACCF)	ADR (+ ACDF)	Total (%)
	13	5	1 (along with ACDF)	19 (45.23%)
Posterior	Laminoplasty	Laminectomy	Laminectomy + Fusion	
	3	8	12	23 (54.76%)
Total				42 (100%)

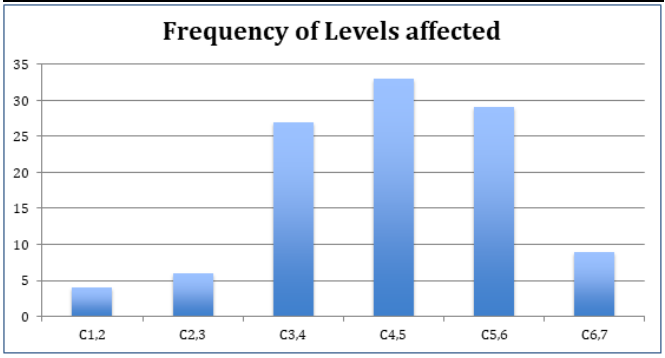

Figure 1: Frequency of levels affected. C4,5 was the most common level affected, closely followed by C3,4 and C5,6.

Nineteen patients underwent anterior surgery, 16 patients underwent 1- or 2-level surgery, while three patients underwent three level surgery (Table 1). One patient underwent a hybrid procedure, in the form of ACDF at the caudal level and a cervical disc arthroplasty at the cephalad level. Five patients underwent corpectomy. All patients underwent iliac crest bone grafting along with anterior cervical plating. Implants were not used in one patient.Among the 23 patients from the posterior group, three patients underwent modified Hirabayashi single door laminoplasty, eight patients underwent laminectomy without fusion, and another 12 patients underwent laminectomy with fusion using lateral mass screws (Table 1).

C4,5 was the level most frequently affected by the myelopathic process (Fig. 1).

Mean stay in hospital was 7.2 (4–15) days. Thirty-two patients underwent instrumented fusions, while 10 patients had uninstrumented surgeries.

One patient died 1 month post-surgery due to steroid related complications, another died after 8 months due to an unrelated malignancy, and eight were lost to follow-up. Mean follow-up was noted as 25.54 (9–66) months in 42 patients.

Functional outcomes

Overall, 34 (81%) patients showed improvement, with 4 (9.5%) patients remaining the same and 4 (9.5%) patients worsened, based on the Nurick scale. Mean Nurick grade (modified) improved from a pre-operative of 3.52–1.64 post-operative (Tables 2 and 3) [2]. Eight patients improved by one

Table 2: Cross-tabulation of pre-operative versus post-operative Nurick score

	NUR	ICK		SCO	RE		POS	T
PRE	0	1	2	3	4	5	6	Total
1	1	0	1	0	0	0	0	2
2	1	1	1	0	0	0	0	3
3	10	2	3	1	0	0	0	16
4	4	1	4	3	2	1	0	15
5	1	0	0	1	0	0	2	4
6	0	0	0	1	1	0	0	2
Total	17	4	9	6	3	1	2	42
%	40.50%	9.50%	21.40%	14.30%	7.10%	2.40%	4.80%	100.00%

Table 3: Functional outcomes from our study

		Pre	Post	Improved	Static	Worsened
Frankel	A	2	0			
	B	1	1			
	C	12	5			
	D	24	12			
	E	3	24			
	Overall	42	42	27 (64.3%)	13 (30.9%)	2 (4.8%)
Nurick		3.52	1.64	34 (80.9%)	4 (9.5%)	4 (9.5%)
Neck Disability Index		42.28	20.28	34 (80.9%)	2 (4.8%)	6 (14.3%)

grade, 9 patients improved by two grades, 12 patients improved by three grades, 4 patients improved by four grades, and 1 patient improved by five grades. Among these included 3 non-ambulatory patients (Grade 5-1, Grade 6-2) who became ambulatory (Grade 3-2, Grade 4-1) (Table 2).Considering the Frankel grading system, 13 (30.9%) patients maintained their neurological status, as before. Overall improvement was seen in 27 (64.3%) patients. Nineteen patients improved by one grade, six patients improved by two grades, two patients improved by three grades. Two (4.8%) patients deteriorated and became ambulatory with support (Grade B and C) post-operative (Table 3).

Neck Disability Index (NDI) was assessed preoperatively and was noted to be 42.28. This improved to 20.28 postoperatively, as noted at last follow-up (Table 3).

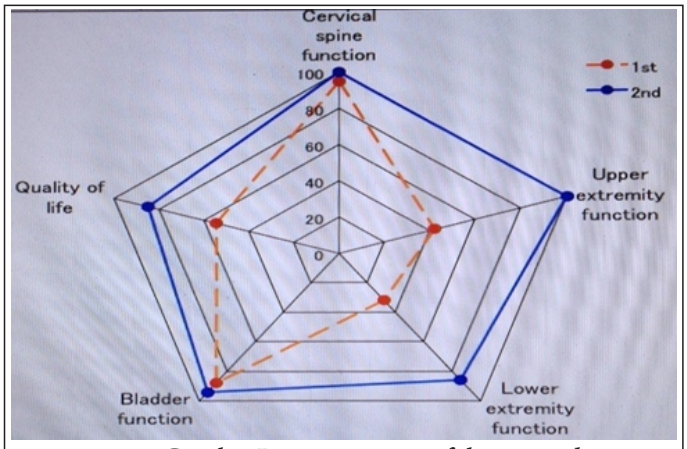

Figure 2: Graphic Representation of the pre and post-operative JOACMEQ scores :

The red pentagram represents the pre-op scores of this patient with predominant affection of upper and lower extremities as well as overall QOL. The blue pentagram shows the post-op scores with significant improvement in all parameters, more so in the affected categories.

JOACMEQ consisted of 24 questions, with variable options to answer from 3 to 5 for each question [3]. These questions were based on the patient's ability to undertake bodily functions and also evaluated overall quality of life. Based on the answers provided by the patient, these scores were tabulated in the software, and they were automatically calculated into five categories – cervical spine function, upper limb function, lower limb function, bladder function, and overall quality of life. Pre-operative as well as post-operative scores were tabulated in the same software, and a diagrammatic representation of the pre- and post-operative scores of JOACMEQ is shown (Fig. 2). The figure displays the degree of improvement in each category from pre- to post-operative condition.

The red pentagram represents the pre-operative scores of this patient with predominant affection of upper and lower extremities as well as overall QOL. The blue pentagram shows the post-operative scores with significant improvement in all parameters, more so in the affected categories. All detailed JOACMEQ scores are tabulated in Table 4. Among the 8 (19.1%) patients, who, felt a reduction in their cervical spine function, seven patients had instrumented fusions (five anterior and two posterior), which was responsible for a reduction in their neck movement.

Table 4: Overall JOACMEQ assessment and statistical analysis

JOACMEQ parameter	Improved – n (%)	Unchanged (static)	Worsened	Median/mean diff –Post to Pre	Wilcoxon signed-rank test (p value)	Statistically significant (P <0.005)
Cervical spine function	15 (35.7%)	19 (45.2%)	8 (19.1%)	12.5	0.085	No
Upper limb function	33 (78.6%)	4 (9.5%)	5 (11.9%)	33.5	0	Yes
Lower limb function	32 (76.2%)	6 (14.3%)	4 (9.5%)	40.5	0	Yes
Bladder function	17 (40.5%)	23 (54.8%)	2 (4.7%)	13	0.002	Yes
Overall QOL	37 (88.1%)	2 (4.8%)	3 (7.1%)	+27.5 (Mean diff)	0.000 (paired T-test)	Yes

Statistical analysis

Statistical analysis was done using the SPSS software (IBM SPSS version 20.0). To assess whether age had any effect on the outcome, patients were divided into three groups, Group A (<45 years), Group B (45–65 years), and Group C (>65 years). Each parameter of the JOACMEQ was assessed against each of these groups and results were derived using the Kruskal–Wallis test. The differences in cervical spine, upper limb, and bladder functions were not statistically significant, but the differences in lower limb function (P = 0.023) and the overall QOL (P = 0.007) scores were statistically significant for Group A, as compared to Groups B and C. However, Group B fared better than Group C (Table 4).

Despite the overall improvement being greater in upper extremities, paired T-tests showed that lower extremities tended to improve more than upper extremities, in terms of degree of improvement. Difference in mean was noted to be 6.14, which was statistically significant. (P = 0.039)

No difference in findings was noted, when patients were grouped according to their level of cervical myelopathy, upper cervical (C1-C2) or lower cervical (C3-C7). Mann–Whitney and independent T-tests demonstrated that differences in

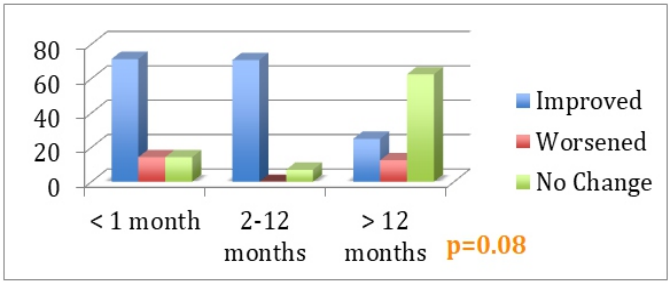

Figure 3: Impact of duration of symptoms on neurological outcome using Frankel Grades: On analysing the duration of symptoms versus the degree of improvement using the Frankel Grades, 22 (70.96%) of 31 patients who presented within the first 12 months, improved, with the remaining either staying the same or deteriorated. (Figure 3) Compared to that, only 2 (25%) of 8 patients presenting after 12 months, improved; while 5(62.5%) remained the same, and 1(12.5%) patient worsened.

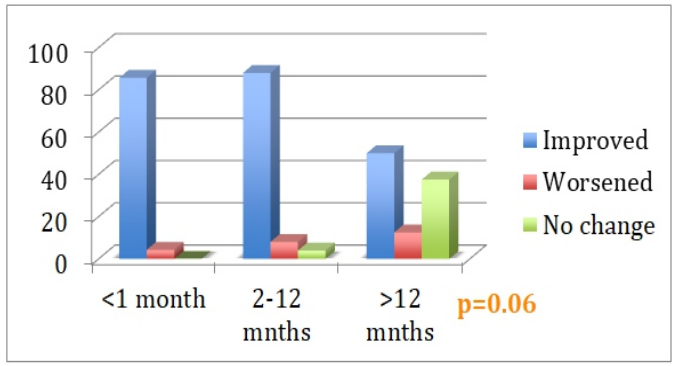

Figure 4: Impact of duration of symptoms on neurological outcomes using Nurick Scale: 28 (87.5%) of patients out of 32, who presented within the first 12 months improved, as compared to only 4 (50%) out of 8 patients who underwent surgery after 12 months from onset of symptoms, using the Nurick scale.

lower extremity and overall QOL were statistically significant for the lower cervical group.

The Kruskal–Wallis test was applied to determine whether pre-operative neurology was a factor affecting the outcome. Improvement was seen across all grades of Frankel and Nurick scores, and the obtained p-values were above the statistically acceptable range ($P > 0.05$). Hence, we concluded that the degree of pre-operative neurological deficit did not have any impact on the eventual outcome. It is possible that our groups were small, and hence, no statistical significance could be achieved in assessing this factor.

On analyzing the duration of symptoms versus the degree of improvement using the Frankel grades, 22 (70.96%) of 31 patients who presented within the first 12 months improved with the remaining either staying the same or deteriorated (Fig. 3). Compared to that, only 2 (25%) of 8 patients presenting after 12 months improved; while 5 (62.5%) remained the same, and 1 (12.5%) patient worsened. Pearson Chi-square test was applied, and $P = 0.08$ was derived. Although not statistically, significant, it may be reasonably concluded that 12 months may be considered an arbitrary number, beyond which positive outcomes tend to drop drastically. Similar results were observed using the Nurick grades instead of the Frankel grades. Twenty-eight (87.5%) of patients out of 32 who presented within the 1st 12 months improved, as compared to only 4 (50%) out of 8 patients who underwent surgery after 12 months from onset of symptoms (Fig. 4).

Complications

Twenty-five (59.52%) of 42 patients remained complication free (Table 5). One patient with wrong level disc excision, required additional fusion level, and one patient with implant impingement required unilateral implant removal. Four patients required reoperations for management of their complications. Four (9.52%) patients developed a major neurological deficit, whereas 5 (11.9%) patients had a minor deficit. Three of the four patients with significant neurological deterioration became independent ambulators, while one patient required support for ambulation. At last follow-up, only one patient who was non-ambulatory from the outset remained so, while all others became ambulators. C5 segmental motor palsy improved in three out of four patients over a period of 6 months, whereas the patient with recurrent laryngeal palsy and Horner's syndrome regained normal voice after 3 months, but the Horner's palsy persisted. One elderly diabetic patient who contracted fungal infection from pulmonary source underwent repeat debridement and ICU admissions twice, but succumbed to the disease after 18 months of primary surgery. Another patient developed steroid-induced gastrointestinal hemorrhage and later died in a separate hospital.

Table 5: Complications following surgery in DCM

	Complication	Pts.	%	Reoperation
Non-	Superficial infection	1	2.38	Y
neurologi	Deep fungal infection causing death	1	2.38	Y
cal	Bone graft donor site infection	2	4.76	Y
-19.04%	Vertebral A. injury	1	2.38	N
	Wrong level disc + fusion	1	2.38	N
	Implant impingement	1	2.38	Y
	High-dose steroid-related death	1	2.38	-
Neurologi	Major deficit (quadriparesis/ hemiparesis)	4	9.52	N
cal	C5 segmental motor palsy	4	9.52	N
-21.42%	Recurrent laryngeal + Horner's syndrome	1	2.38	N

Discussion

Ever since the publication of the JOACMEQ, in 2007; no other study has utilized this questionnaire to evaluate the outcomes of surgery in a cohort consisting of Indian patients, for greater than 2 years [3]. To the best of our knowledge, ours is the first study to demonstrate the efficacy of JOACMEQ in evaluating

the surgical outcomes at more than 2 years. The JOACMEQ offers a deep insight into the five categories of neurological deterioration associated with DCM and also provides a numerical value to assess the pre- and post-operative outcomes.

Overall, 81% of our DCM patients improved following surgery, while 9.5% remained the same and an equal number worsened. A similar percentage (85.5%) of positive surgical outcomes has been demonstrated by Chang et al. following laminectomy with fusion in patients of cervical spondylotic myelopathy. (CSM) [4]. Al-Tamimi et al. demonstrated improvement in QOL in 70% of patients treated surgically, across generic as well as condition specific HR-QOL questionnaires [5].

In our study, we found a significant improvement in lower extremity function, as well as overall QOL in the <45 years Group A (P = 0.023 for lower limbs; P = 0.007 for QOL). The improvement was statistically significant for both the other groups, with the 45–65 years Group B faring better than the >65 years Group C. This was in complete concordance with Morio et al. who concluded that younger age at time of presentation correlated positively with surgical outcomes [6]. Karpova et al. also concluded that age <65 years had lower pre-operative JOA scores and was highly predictive of a positive surgical outcome [7]. Maxwell conducted a nationwide database search and demonstrated that patients older than 65 years had 14-fold increase in mortality compared to younger patients <45 years old [8].

Time and again various authors have established the usefulness of laminoplasty in DCM, with equivalent results in the younger and the elderly population [9, 10]. Excellent surgical outcomes have also been demonstrated by Chang et al. following laminectomy with fusion [4]. A recent multicenter study by Fehlings et al. demonstrated equal efficacy by either an anterior or posterior approach for CSM [11]. A systematic review on anterior versus posterior approach, by Lawrence et al demonstrated equivalent results with both approaches [12]. In our study, we did not find any significant difference in outcome, based on the type of approach, anterior or posterior; nor between laminoplasty and laminectomy, with or without fusion.

Although, statistically not significant, we were able to reasonably conclude that a symptom duration of <12 months did not alter the surgical outcome, whereas patients undergoing surgery after 12 months had a far less favorable outcome. Morio et al. concluded that symptom duration correlated positively with surgical outcomes, although no definite time duration was concluded upon [6]. Karpova concluded that duration of symptoms correlated well with pre-operative functional status, but did not affect post-operative results [7]. Gao et al. used logistic regression analysis in their study to conclude that symptom duration >12 months, along with high intensity signal in the spinal cord, and pre-operative JOA score of ≤9, was predictive of a fair (<50) recovery rate using Hirabayashi's method [13, 14].

Many authors have reported significant influence of pre-existing neurology as a factor affecting outcome [7, 11, 13]. However, in our series, no such difference was noted, as we noticed significant improvement across all Nurick and Frankel grades.

Overall incidence of complications following surgical management of CSM has been quoted between 18 and 20% [15]. Some articles have quoted a low 10.6% incidence of complications with laminectomy with fusion [4]. Maxwell calculated an overall incidence of 13.4% for complications arising out of spinal fusion surgery from the national database of the US [8].

We had a significantly higher (40.5%) incidence of complications in our series. This could be attributed to a smaller number of patients in our cohort, and also due to the fact, that neuromonitoring was not available for any of these procedures. If any intraoperative alerts were made available, perhaps, the technique may have been altered or aborted, thus leading to a lesser degree of complications. Although majority of the complications were of transient nature, 4 (9.52%) patients had a permanent complication. One vascular injury, one Horner's syndrome, one quadriparesis, and one fungal infection progressing to death of the patient were of permanent nature.

Overall incidence of transient C5 palsy following a posterior decompression of the cervical spine has been noted around 7–8% [16, 17, 18]. Chiba et al. noted a C5 or C6 segmental palsy of 10.8% in their cohort of 80 patients, followed for more than 10 years. All except one had recovered within 2 years, in their series [19]. Tanaka noted occurrence of 3 cases of C5 palsy following laminoplasty without any intraoperative MEP changes in those patients [20]. Similarly, Chang et al. had 6.9% incidence of post-operative C5 palsy in their 52 patients who underwent laminectomy with fusion for CSM [4]. We encountered segmental post-operative C5 palsy in 4 (9.52%) patients, of which three recovered completely and one partially, within 8 months.

We have purposefully omitted the correlation between the radiological findings on MRI with functional outcomes, as the focus of this article is mainly clinical outcomes, and clinical variables that have an effect on outcomes. Moreover, scientific evidence on radiological correlation with outcomes has been published quite a few times in the medical literature.

Conclusion

We can reasonable conclude that lower extremities and quality of life tended to improve more in younger individuals, as did patients with subaxial cervical pathology. Lower extremities

tended to improve more than upper extremities. Pre-operative symptom duration of more than 12 months had a negative impact on the functional outcome. Pre-operative neurological status, type of approach, or instrumentation did not have any bearing on the functional outcomes in our group of patients. Overall, majority of the patients showed significant improvement in their functional outcome scores. This suggests the rewarding nature of decompressive techniques, even though late, in patients with degenerative cervical myelopathy.

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