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Original Research Article

A Study of Outcome of Foramen Magnum Decompression and Duraplasty for Chiari Malformations

Dr. Sreedharala Srinivasa Satynarayana[1], Dr. Palukuri Lakshmi[2*], Dr. Sandeep Raja Pittala[3], Dr. Uday Goutam Nookathota[3], Dr. Alluri Neeraja[3], Dr. Kotha Arjun Reddy[3]

[1]M.S., M.Ch., I/c Prof. of NeuroSurgery, Gandhi Medical College, Telangana State, India
[2]Assoc Prof. of Plastic Surgery, Osmania Medical College, Hyderabad, Telangana State, India
[3]Postgraduates in Department of Neurosurgery Department of Neurosurgery, Gandhi Medical College, Gandhi Hospital, Secunderabad, Telangana

***Corresponding author**
Dr. Palukuri Lakshmi
Email: lakshmi_ahlad@yahoo.co.in

Abstract: Chiari malformations appears to be complex in its presentation, cause and natural history. The true incidence is not known. Around 3% in children and 1% in adults demonstrate radiological evidence, and all cases need not be symptomatic. There are various surgical options, expansion of foramen magnum has been widely accepted. There are controversies in current surgical strategies. We evaluated the efficacy of foramen magnum decompression and duraplasty alone without any additional procedure in 30 patients. The outcome was assessed by using Chicago Chiari Outcome Scale (CCOS). We observed that, the foramen magnum decompression and duraplasty in cases of chiari malformations with Syrinx is associated with good clinical and radiological outcome. In conclusion, foramen magnum decompression and duraplasty is alone enough, even for the management of Syrinx in cases of chiari malformation with syrinx.
Keywords: Chiari malformations, Chicago Chiari Outcome Scale (CCOS), foramen magnum

INTRODUCTION

Chiari malformations were described in detail by Dr. Hans Chiari, and defined by him as tonsillar ectopia located below the level of foramen magnum. The malformations appears to be complex in its presentation, cause, and natural history. These are now being identified increasingly as a result of advances in MR imaging. The true incidence of these malformations is not known. Large institutional studies have shown that around 3% of children and 1% of adults demonstrate radiographic evidence of Chiari malformation and all the cases need not be symptomatic .The disease has considerable morbidity in terms of affecting the quality of life.

There are various surgical treatment options for Chiari malformations with and without syringomyelia. The surgical options include, foramen magnum decompression with or without duraplasty and cerebellar tonsillectomy. For syrinx, syringo-subarachnoid shunt placement is tried along with Foramen magnum decompression. The optimal approach is still unclear as there are controversies in current surgical strategies. However, the expansion of foramen magnum has been widely accepted as a single surgical procedure of choice.

The shape of cerebellar tonsils and medulla undergoes a gradual recovery to normalcy after surgery as seen in imaging studies.

The present study is aimed at evaluating the efficacy of Foramen Magnum Decompression and Duraplasty alone without any additional procedure in Chiari malformation and its effect on the symptoms and imageology, particularly on the associated syrinx.

PATIENTS AND METHODS

This study is a retrospective and prospective study consisting of 30 patients who presented to our institute between July 2011 to December 2016. All patients who are diagnosed to have Chiari

malformations and who underwent Foramen Magnum Decompression and duraplasty were included in this study.

The surgery was done in prone position, a standard suboccipital craniectomy of 3- to 4-cm diameter with C1 laminectomy was done, dura was opened in Y shaped manner, any arachnoid adhesions present were released. Duraplasty was done with autologous fascia lata, closure was done in layers and muscle layer was closed tightly to prevent CSF leaks.

The preoperative symptoms were documented and thorough clinical examination was done along with preoperative MRI. Following surgery the postoperative symptoms were evaluated and compared with preoperative symptoms. Follow up MRI was done within 6 months of surgery and syrinx status was compared with preoperative syrinx. Functional outcome was assessed at the end of 6 months /1 year /2 year and 3 year.

The cases with severe motor symptoms in form of wasting of muscles were excluded from this study as these cases needed syringothecal shunt placement along with Foramen Magnum Decompression. Outcomes were assessed using Chicago Chiari Outcome Scale (CCOS) which uses 4 postoperative outcome categories - pain symptoms, non- pain symptoms, functionality and complications.

Informed consent was taken from all the patients and institutional ethical committee approval was obtained for the study. Statistical analysis of data was done using appropriate tools.

RESULTS

Age

The mean age of patients in the present study is 27.53 years (SD 14.85). Five patients were below 15 years of age and three patients were above 50 years of age.

Sex

22 (73.3%) of the patients were male and 8(26.7%) were females.

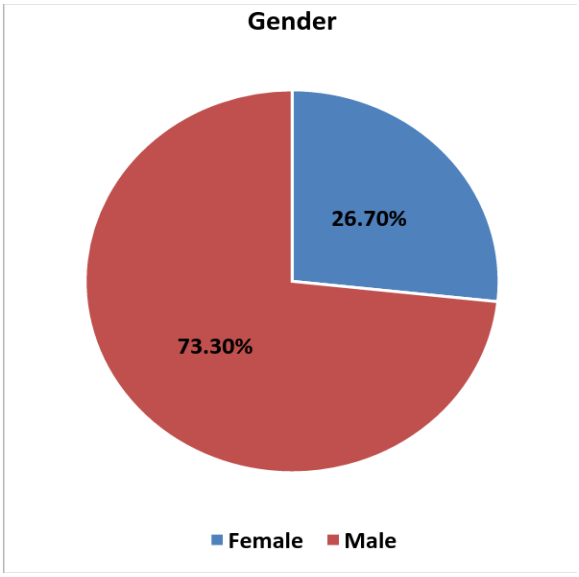

Fig-1:

Duration of symptoms

The mean duration of symptoms noted in this study is 14.77 months (SD 10.32).

The following are the presenting symptoms: **(Table-1)**

Table 1:

Symptom	Number of Patients	%
Headache	9	30%
Neck Pain	23	76.7%
Upper Extremity Pain	9	30%
Lower Extremity Pain	1	3.3%
Tingling Numbness UE	22	73.3%
Tingling Numbness LE	3	10%
Weakness of UE	13	43.3%
Weakness of LE	4	13.3%
Blurring of Vision	4	13.3%
Double Vision	1	3.3%
Head Tilt	2	6.7%
Difficulty in Swallowing	1	3.3%
Decreased Sensations UE	9	30%
Decreased Sensations LE	2	6.7%
Decreased Sensations Trunk	2	6.7%
Others	2	6.7%

The following are signs present on examination:
(Table-2)

Table 2:

Signs	Number of Patients	%
Sensory Deficits	21	70%
Balance Impairment	7	23.3%
Upper Extremity Weakness	16	53.3%
Nystagmus	1	3.3%
Diminished Gag Reflex	1	3.3%
Lower Extremity Weakness	7	23.3%
Gait Impairment	12	40%
Scoliosis	2	6.7%
Increased Lower Extremity Tone	12	40%
Up Going Plantars	6	20%
Others	3	10%

MRI Findings

All the cases had cerbellar tonsillar herniation of varying lengths the maximum being 20 mm. 24(80%) of patients had syrinx pre operatively.

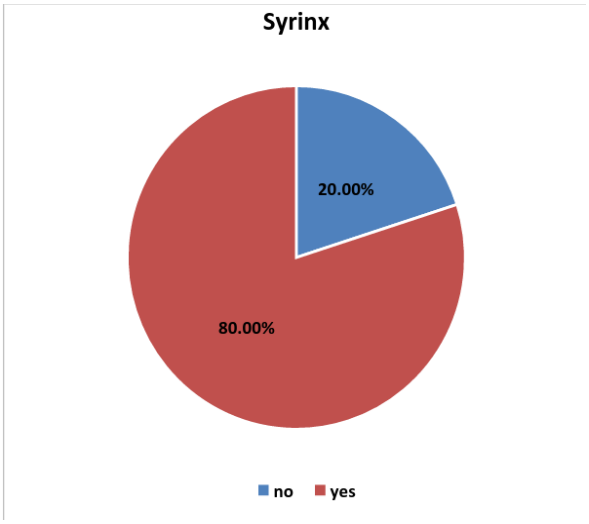

Fig-2:

Table 3

Location of Syrinx	Number of Patients	%
Cervical	2	8.3%
Cervical/ Dorsal	18	75%
Cervical /Dorsal /Lumbar	4	16.6%

Associated Conditions

5 (16.6%) patients had Hydrocephalus which needed placement of VP Shunt. Scoliosis was present in 2 (6.6%) patients. Meningomyelocele were present in 2(6.6%) patients which were operated earlier.

Surgical Procedure

All the 30 patients underwent Foramen Magnum Decompression with Duraplasty using fascia lata graft. One patient with worsening symptoms needed an additional procedure i.e. Syringo Thecal shunt. One patient needed Tracheostomy for breathing difficulty postoperatively and one patient needed re exploration for persistent CSF leak from the wound.

Complications

The following complications were noted: **(Table-4)**

Table 4

Nil	24	80 %
Persistent CSF Leak	1	3.3%
Meningitis	1	3.3%
Pseudomeningocele	1	3.3%
Breathing Difficulty	1	3.3%
Superficial Wound infection	2	6.7%

Hospital Stay

The mean Hospital stay was 11.97 days (SD 5.29) **(Table-5)**

Table 5

	Mean	SD	N
Age in years	27.53	14.85	30
Duration of symptoms in months	14.77	10.32	30
Hospital stay in days	11.97	5.29	30

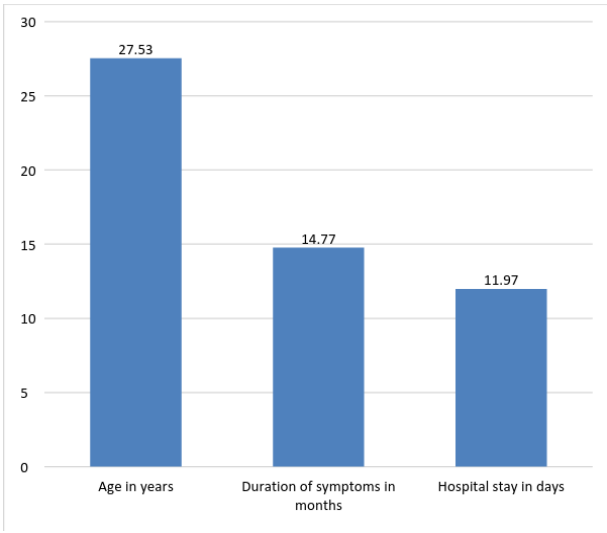

Fig-3

Follow up

5 patients could not be followed up. 25 patients could be contacted. The follow up duration ranged from 6 months to 4 years.

19 of 25 patients experienced improvement in symptoms, 5 patients had no change in their symptoms, while one patient worsened clinically after the surgery which needed second procedure i.e. Syringo Thecal Shunt.

Postoperative Clinical Outcomes

Table 6

Improved	19	76%
Unchanged	5	20%
Worsened	1	4%

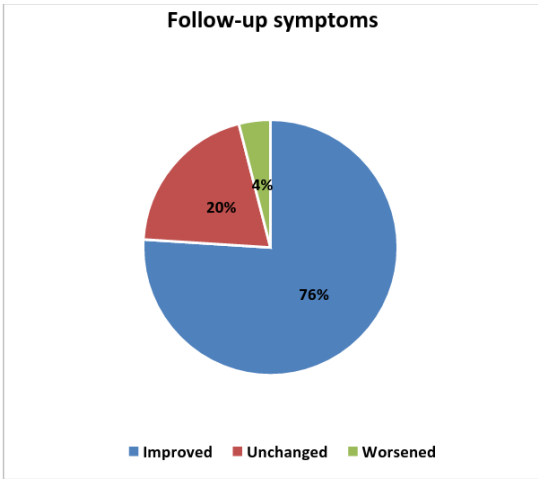

Fig-4

Postoperative Chicago Chiari Outcome Score (CCOS): (Table-7)

Table 7

CCOS Total	4-8	1	4.0%
	9-12	6	24.0%
	13-16	18	72.0%

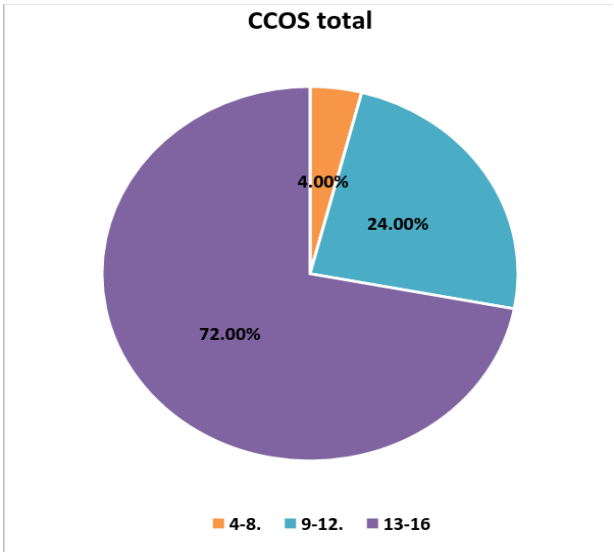

Fig-5

Follow up MRI

Follow up MRI could be done in 14 patients, of which one did not have syrinx pre operatively. **(Table-8)**

Table 8

Post OP Syrinx	Decreased	8	61.5%
	Unchanged	4	30.7%
	Increased	1	7.7%

Statistical Analysis of the data

There is no statistical significance between the age of patient and clinical outcome**. (Table-9)**

Table 9

	Follow up symptoms						**p-value**
	Improved			**Unchanged**			
	Mean	**SD**	**N**	**Mean**	**SD**	**N**	
Age in years	29.16	15.73	19	29.60	7.09	5	0.454; NS

Mann-Whitney U test

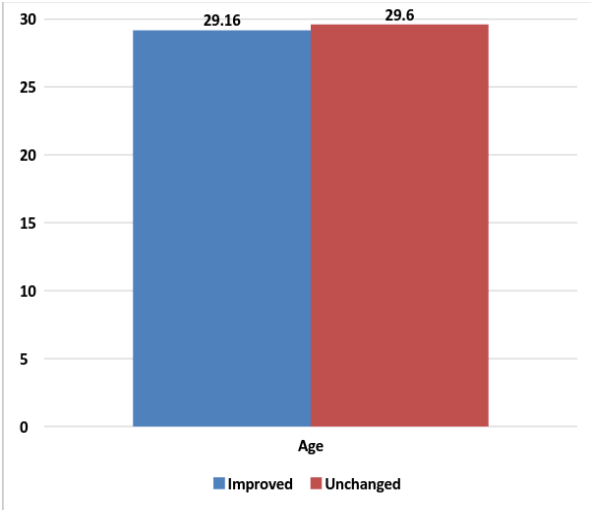

Fig-6

There is no statistical significance between the duration of symptoms and clinical outcomes. **(Table-10)**

Table 10

	Follow up symptoms						p-value
	Improved			Unchanged			
	Mean	SD	N	Mean	SD	N	
Duration of symptoms in months	15.42	10.08	19	10.60	8.17	5	0.332; NS

Mann-Whitney U test

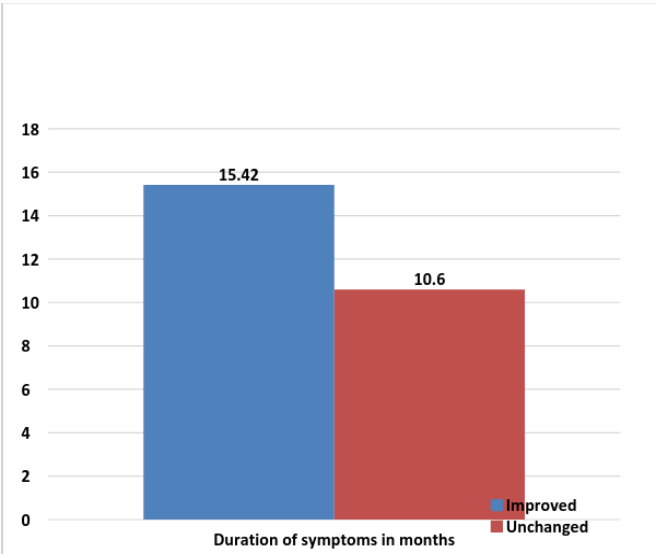

Fig-7

There is no statistical significance between the location of syrinx and the clinical outcome.

In the present study there is decrease in syrinx size in 8 cases who improved clinically, additionally two patients improved clinically but the syrinx status remained unchanged. The relationship between size of syrinx post operatively and clinical improvement did not attain statistical significance. **(Table-11)**

Table 11

		Follow up symptoms				p-value
		Improved		Unchanged		
		N	%	N	%	
Location of Syrinx	Cervical	1	6.3%	1	25.0%	0.162; NS
	Cervical, Dorsal	14	87.5%	2	50.0%	
	Cervical, dorsal, Lumbar	1	6.3%	1	25.0%	
Syrinx size Status Post OP	Decreased	8	80.0%	0	.0%	0.091; NS
	Unchanged	2	20.0%	2	100.0%	

Fisher's exact test

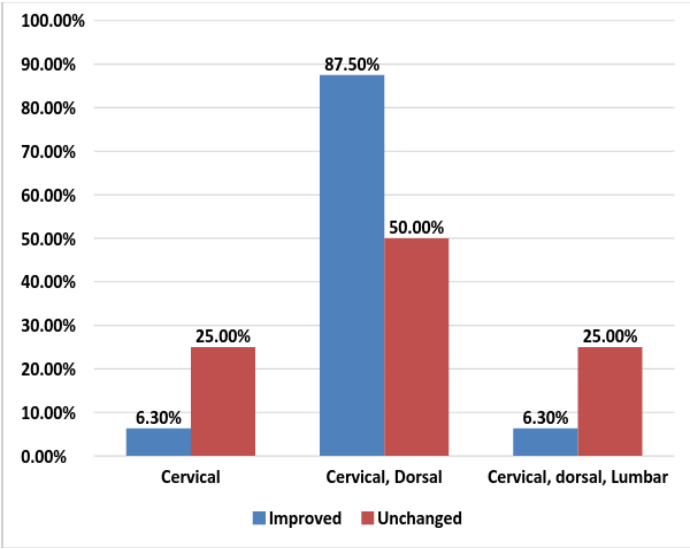

Fig-8

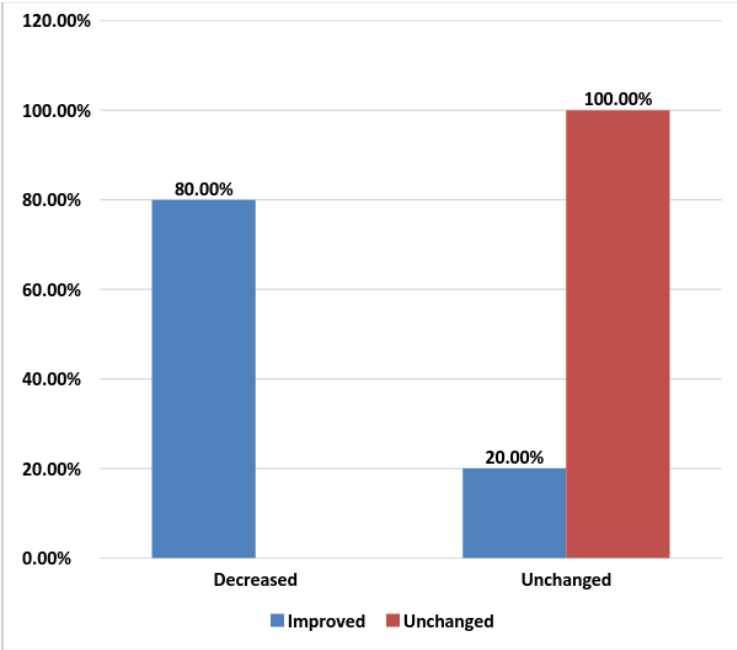

Fig-9:

The relationship between size of syrinx and post op CCOS attains statistical significance (p<0.003) **(Table-12)**

Table 12

		Syrinx Size Status Post OP						p-value
		Decreased		Increased		Unchanged		
		N	%	N	%	N	%	
CCOS Total	4-8	0	.0%	1	100.0%	0	.0%	0.003; Sig
	9-12	0	.0%	0	.0%	3	75.0%	
	13-16	8	100.0%	0	.0%	1	25.0%	

Fisher's exact test

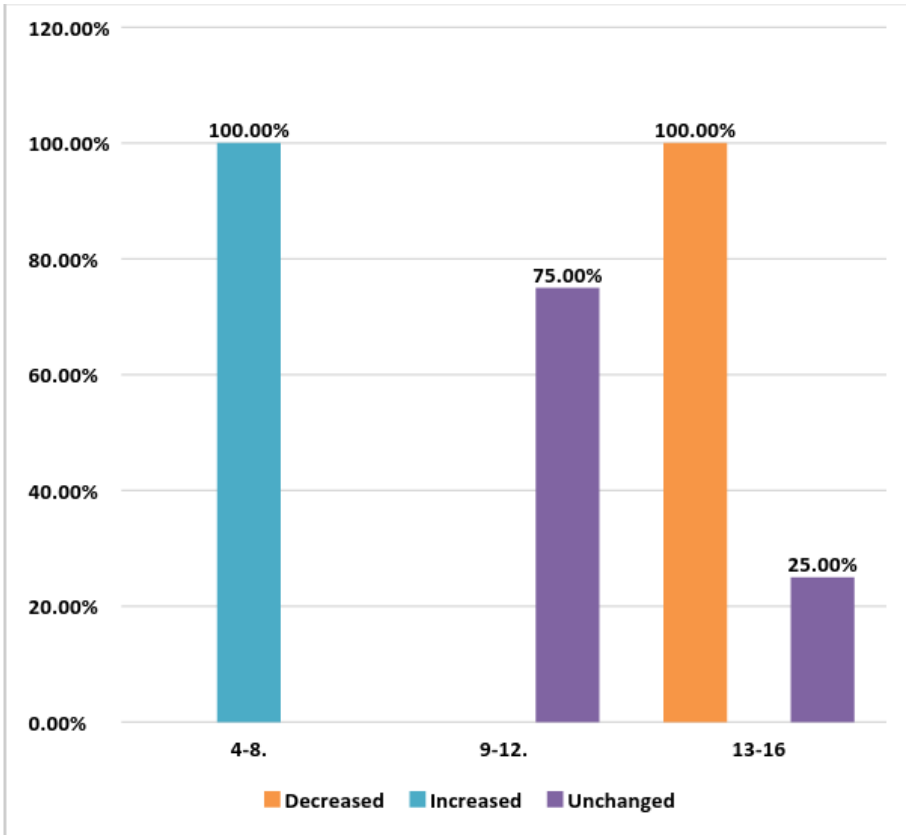

Fig-10

DISCUSSION

The present study is aimed at clinical and radiological outcomes of patients with Chiari malformation and status of syrinx after surgery who underwent Foramen Magnum Decompression and Duraplasty.

The goals of surgery according to Jian-Lan Zhao *et al* [1] were to relieve the compression at the cervicomedullary junction, to establish adequate circulation of CSF flow at foramen magnum, and to reduce the size of syrinx.

Aghakhani *et al* [2] in their study of 157 cases with Chiari related syringomyelia proposed that Foramen Magnum Decompression and duraplasty is recommended as the initial procedure to be performed, as they obtained favourable results clinically and radiologically in their series without an additional procedure like syrinx shunting. Jian-Lan Zhao *et al* [1] in their study analysed 18 studies in which outcomes after surgery in Chiari malformations were measured clinically and radiologically.

In this study out of 1242 patients 721 patients who underwent Foramen Magnum Decompression and duraplasty had favourable outcome compared other methods like syrinx shunting and Foramen Magnum Decompression and .this is the preferred method in majority of studies. Some authors have suggested that syringostomy or syringo-subarachnoid shunt is unnecessary because there is no significant relationship between clinical findings and size of syrinx and direct treatments that eliminate syrinx may not produce clinical improvement [3]. Based on the favourable results in previous studies we performed Foramen Magnum Decompression and Duraplasty as initial procedure in all cases and in cases even with syrinx.

Age distribution

The majority of patients in the present study belong to 2nd decade with mean age of 27.53 years. The mean age in majority of other studies is above 33 years. The mean age in the present study is comparable with the findings of Millhorat *et al* [3] and R Kumar *et al* [4].

Table 13:

Study	Mean age in years
D Mueller and J J Oro [6]	40 (SD 11.3)
Scott Parker *et al* [7]	39(SD 13)
Xiafeng Deng *et al* [8]	33.1 (SD 11.2)
Aghakhani *et al* [2]	30.9(SD 14.9)
JorgKlekamp [9]	40(SD 16)
V N Vakharia *et al* [10]	33.4(SD 17.2)
R Kumar *et al* [4]	26.14 (SD 12.24)
Millhorat *et al* [3]	24.9 (SD 15.8)
Leonard Aliaga *et al* [11]	20.0 (SD 16.7)
Present study	27.53 (SD 14.85)

Sex distribution

There is a clear female preponderance in all the studies .In the present study there were 22 males and 8 females and only in the study by R Kumar *et al* [4] there is male preponderance.

Table 14:

Study	M : F
D Mueller and J J Oro [6]	82:104
Scott Parker *et al* [7]	14: 36
Xiafeng Deng *et al* [8]	52:100
Aghakhani *et al* [2]	74:83
JorgKlekamp [9]	118:241
V N Vakharia *et al* [10]	21:40
Jian- Lan Zhao *et al* [1]	470:713
R Kumar *et al* [4]	48:39
Present study	22:8

Duration of symptoms

The mean duration of symptoms in our study is 1.23 years which is shortest among all the previous studies. In the study by Aghakhani *et al* [2] the mean duration was 8.22 years the longest amongst all studies.

Table 15:

Study	Years	No. of Patients
Aghakhani *et al* [2]	8.22	157
D Mueller and J J Oro [6]	6.3	265
Xiafeng Deng *et al* [8]	5.5	152
Z Q Zhang *et al* [5]	4.51	316
N M F El Ghandour [12]	1.96	46
Present study	1.23	30

Presenting signs and symptoms

The most common presenting symptom in the present study is neck pain (76%) which is present in 48 % of the cases in the study by R G Ellenbogen *et al* [13] and in 78% of patients in the study by D Muller and JJ Oro [6]. In this study the neck pain is described as stiffness, dull or aching or stabbing, range of motion was also affected .Similar findings were noted in the present study.

Weakness of extremity was present in 76.7% of the patients which was seen in 65% of patients in the study by D Muller and JJ Oro [6]. Headache was seen in 30% of the patients in the present study compared to 66% in study by C Hayhurst *et al* [14] and 97% by D Muller and JJ [6]. Scoliosis was seen in two (6.7%) of the patients in contrast to 9% in study by C Hayhurst *et al* [14].

Dysphagia and lower cranial nerve palsy was found in one patient. An uncommon presenting feature in this study is head tilt in two(6.7%) children which was found in one child in a study by Sunil V Furtado *et al* [15]. Hydrocephalus was present in 5 patients needing Ventriculo peritoneal shunting Two children had meningomyelocele which was repaired earlier.

Table 16:

Study/No of patients	Symptoms/Signs	Percentage
R G Ellenbogen *et al* [13] (n=29)	Headache Neck Pain Sensory Loss Ataxia Scoliosis	100% 48% 45% 6% 1%
R Kumar *et al* [4] (n=87)	Neck pain Weakness Spasticity Headache Dysphagia	50.6% 39.1% 25% 21.8% 12.6%
C Hayhurst *et al* [14] (n=96)	Headache Weakness Altered Sensation Ataxia Scoliosis	66% 35% 15% 14% 9%
D Muller and JJ Oro (n=112) [6]	Headache Neck pain Vision changes Extremity weakness Extremity numbness	97% 78% 71% 65% 65%
Aghaknani *et al* [2] (n=152)	Neck pain Sensory disturbances Motor weakness Ataxia Scoliosis Dysphagia Diplopia	38.2% 22.92% 17.2% 8.91% 5.73% 1.91% 0.64%
Xiaofeng Deng *et al* [8] (n=152)	Motor dysfunction Numbness Neck pain Dysphagia Ataxia Diplopia	25.6% 28.2% 8.5% 6.5% 3.94% 1.9%
Present study (n=30)	Neck pain Extremity weakness Sensory deficits Extremity pain Headache Visual disturbances Scoliosis Head tilt Dysphagia	76.7% 76.7% 70% 33.3% 30% 16.7% 6.7% 6.7% 3.3%

Common Presenting symptoms and signs.

Syrinx in MRI

Pre operative MRI in all cases had tonsillar descent the maximal descent was observed to be 20 mm. In the present study 80%(24) of cases had syringomyelia.

Table 17:

Tisell M *et al* [16]	50 %
C Hayhurst *et al* [14]	55.4 %
N M F El Ghandour [12]	69.5%
Richard Ellenbogen [13]	76%
Present study	80%

Material used for duraplasty

In this study fascia lata was used for duraplasty and except in one cases with postoperative CSF leak no complication was reported.

Historically a variety of dural substitutes were used like cadaver pericardium, autologous pericranium. autologous fascia lata and synthetic dural substitute like e PTFE (expanded polytetrafluoroethylene). Abla AA *et al* [17] in their study of dural grafts in Chiari decompression surgery found that none among autologous or nonautologous grafts were superior, they however recommended that autologous pericranium to be used as it is non-immunogenic, inexpensive and capable of creating a watertight closure with the dura.

In contrast. JorgKlekamp *et al* [9] say that autologous material use was associated with higher rates of postoperative deterioration compared with alloplastic materials. This may be attributed to formation of adhesions underneath the autologous material compromising CSF flow

Complications

Complications were present in 6(20%) of the cases in the present study Superficial Wound infection (6.7%) was most common complications noted .One patient had respiratory distress needing tracheostomy, this patient presented with recurrent aspiration pneumonitis preoperatively and hence can be excluded as a complication of surgery. One patient needed re exploration of wound for persistent CSF leak.

The pseudomeningocele of the patient resolved in 2 months follow up, hence complications were noted in 4 (13.3%) patients only.

In the study by Jian-Lan Zhao et al[1] out of the 1242 patients included 6.3% had meningitis and CSF leak was present in 4.1 % of the patients. The meningitis described is aseptic meningitis ascribed to use of synthetic dural substitute. This study also describes a 30 day mortality of 0.97% mostly ascribed to respiratory and thromboembolic complications. No mortality was recorded in the present study and all complications were managed appropriately.

Table 18:

Study/No of patients	**Complication**	**Percentage**
N M F El Ghandour [12] (n=46)	Meningitis CSF leak Wound infection Pseudomeningocele	4.3% 2.2% 2.2% 2.2%
Xiaofeng Deng *et al* [8] (n=152)	Meningitis CSF Leak	4.6% 0.6%
Aghakhani *et al* [2] (n=157)	Meningitis Pseudomeningocele CSF Leak	3.82% 1.2% 0.6%
R Kumar *et al* [4] (n=87)	CSF Leak Wound infection Respiratory distress Wound infection	8.0% 3.4% 2.2% 1.1%
Jian-Lan Zhao *et al* [1]	Meningitis	6.3%

(n=1242)	CSF Leak Wound infection Swallowing difficulty Respiratory distress Pseudomeningocele	4.1% 1.4% 0.9% 0.6% 0.5%
Present study (n=30)	Superficial wound infection Persistent CSF Leak Meningitis Pseudomeningocele Respiratory distress	6.7% 3.3% 3.3% 3.3% 3.3%

Post operative status

Out of 25 patients who could be followed up postoperatively at least 6 months of surgery to 4 years of surgery 19 (76%) showed improvement in their preoperative symptoms This is comparable to the studies of J Lan Zhao *et al* [1], Z Q Zhang *et al* [5], J Klekamp [9], C Hayhurst *et al* [14].

In the present study the symptoms were static in 5(20%) patients and in one patient there was clinical worsening. These percentages are comparable with previous studies.

Table 19:

	J Lan Zhao *et al* [1] (n=1242)	ZQ Zhang *et al* [5] (n=218)	J Klekamp [9] (n=371)	R Kumar *et al* [4] (n=87)	C Hayhurst *et al* [14] (n=96)	Aghakhani *et al* [2] (n=157)	Xiaofeng Deng *et al* [8] (n=152)	Present study (n=25)
Improved	79.95%	80.4%	73.6%	45.9%	78%	63.06%	82.9%	76%
Unchanged	14.09%	15.6%	21.0%	43.7%	20%	30.58%	13.8%	20%
Worsened	6.09%	3.9%	5.5%	10.3%	2%	5.73%	3.3%	4%

Postoperative syrinx status

Out of the 13 patients who had postoperative MRI the syrinx decreased in 8 (61.5%) of patients and remained static in 5 (30.7%) of patients and one patient had increase in syrinx size which needed a second procedure syringo-thecal shunt, which can be considered as a failure of the primary procedure.

In Spite of small numbers the percentages of patients with decreased syrinx size is comparable with the studies of Z Q Zhang *et al* [5] and Xiaofeng Deng *et al* [8].

Table 20:

	JLan Zhao *et al* [1] (n=822)	ZQ Zhang *et al* [5] (n=218)	Xiaofeng Deng *et al* [8] (n=112)	JKlekamp [9] (n=281)	Alex Alfieri *et al* [18] (n=109)	N M F El Ghandour [12] (n=32)	C Hayhurst *et al* [14] (n=46)	Present study (n= 13)
Decreased	78.47%	66.51%	65.2%	81.1%	29.3%	87.5%	86.9%	61.5%
Unchanged	15.82%	26.15%	34.8%	15.2%	56.8%	12.5%	13.1%	30.7%
Increased	5.72%	7.34%	----	3.7%	13.7%	----	---	7.7%

CCOS (Chicago Chiari Outcome Score)

Outcome assessment after surgery for Chiari malformation is difficult because of the lack of a reliable and unified scoring system [11].

Aghakhani *et al* [2] state that there are no clear or reproducible clinical scores to analyze patient outcome. The constellation of presenting symptoms of CM1 can be quite variable [3,6]. The estimation of whether surgical intervention will result in benefit is not always clear. Previous studies use outcome labels such as “improved,” “unchanged,” or “worse,” or some variant of this scheme.

The CCOS is multifaceted, and addresses the various nuances in outcome. The CCOS uses 4 postoperative categories to assess outcomes: pain symptoms non-pain symptoms, functionality (ability to attend work or school), and complications.

Pain symptoms commonly included tussive headache, neck and shoulder pain, and dysesthesia in the upper extremities.

Non-pain symptoms commonly included dysphagia, ataxia, vertigo, muscle weakness, sensory loss, tinnitus, paresthesias, and drop attacks, as well as signs, such as presence of syrinx or other neurological signs.

Functionality, meaning the patient's ability to attend work, school, or usual daily responsibilities, was also assessed at the last hospital visit.

Surgical complications were assessed throughout patient's postoperative course, from the time of surgical decompression to the last hospital visit. They included typical surgical complications such as wound infection, chemical meningitis, and CSF leak.

CCOS quantifies specific aspects of outcomes following PFD in order to better predict how well surgery will treat a patient with a specific constellation of presenting complaints, because not all symptom constellations respond equally to surgery. A nuance of the CCOS in that overall patient outcome score in the CCOS is weighted more toward absolute outcome rather than outcome relative to preoperative symptoms. The merit of this aspect of the CCOS is that absolute outcome (as opposed to relative outcome) can be correlated with preoperative severity of disease-a comparison that the I/U/W (Improved, Unchanged, Worsened) scoring cannot support.

In their study Leonardo Aliaga *et al* [11] CCOS score groupings (4-9, 8-12, 13-16) from approximately 8% of the patients did not correlate with the corresponding I/U/W outcome group. These patients can be examined to find trends or reasons for the discrepancy between CCOS score and I/U/W outcome.

In the present study one patient had score of 12 but symptomatically improved. Limitations of using simple outcome labels, such as the I/U/W, are the subjective nature of the evaluation and absence of uniform outcome measures.

A patient may improve in one aspect but worsen in another by differing degrees, and may still have either an overall improved or unchanged outcome. The CCOS aims to lessen this subjectivity by assigning a number based on defined levels in well-separated categories.

Chicago Chiari Outcome Scale

Pain	Non-pain	Functionality	Complications	Total Score
1 - Worse	1 - Worse	1 - Unable to attend	1 - Persistent complication, poorly controlled	4 - Incapacitated outcome
2 - Unchanged and refractory to medication	2 - Unchanged or improved but impaired	2 - Moderate impairment (<50% attendance)	2 - Persistent complication, well controlled	8 - Impaired outcome
3 - Improved or controlled with medication	3 - Improved and unimpaired	3 - Mild impairment (>50% attendance)	3 - Transient complication	12 - Functional outcome
4 - Resolved	4 - Resolved	4 - Fully functional	4 - Uncomplicated course	16 - Excellent outcome

Fig-11

Table 21:

CCOS Total	4-8	1	4.0%
	9-12	6	24.0%
	13-16	18	72.0%

Table 22:

Improved	19	76%
Unchanged	5	20%
Worsened	1	4%

One patient in the improved category had CCOS score 12 and hence discrepancy seen in CCOS scores versus I/U/W classification

Analysis of data

In the present study there is no statistical significance between improvement and age of patient (p=0.454).

In the study by Alex Alfieri *et al* [18] they found that there is statistical significance between age and clinical improvement, and according to this study older age at surgery negatively influenced the outcome. Similarly, Aghakhani et al[2] in their study found that there is a higher probability of improvement or stabilization in young patients.

There is no statistical significance between duration of symptoms and clinical improvement (p=0.332) Alex Alfieri *et al* [18] found that longer duration of symptoms negatively influence the outcome.

The relationship between size of syrinx post operatively and clinical improvement did not attain statistical significance.(p=0.091)In the present study there is decrease in syrinx size in 8 cases who improved clinically ,additionally two patients improved clinically but the syrinx status remained unchanged, N M F El Ghandour [12] in their study state that clinical improvement occurs earlier than syrinx size in postoperative MR imaging.

There is no correlation between specific syrinx size and clinical condition, this is reflected in two patients in the present study who improved clinically but the syrinx remained unchanged in MR imaging.

According to Xiaofeng Deng *et al* [8] patients with motor dysfunction revealed a lower recovery rate than the others. In the present study out of 5 patients whose symptoms remain unchanged 3 had motor dysfunction and one patient who worsened also had motor dysfunction.

An important finding in this study is that the relationship between size of syrinx and post op CCOS attains statistical significance (p<0.003).

Table 23:

		Syrinx Size Status Post OP						**p-value**
		Decreased		**Increased**		**Unchanged**		
		N	**%**	**N**	**%**	**N**	**%**	
CCOS Total	4-8	0	.0%	1	100.0%	0	.0%	0.003; Sig
	9-12	0	.0%	0	.0%	3	75.0%	
	13-16	8	100.0%	0	.0%	1	25.0%	

CONCLUSION

Chiari malformations with syrinx are a neurosurgical challenge, with complex pathophysiology and with varied surgical options. Foramen Magnum Decompression and Duraplasty is a safe and effective surgical option, it provides significant and sustained improvement in symptoms by establishing CSF flow at foramen magnum and reducing the size of syrinx radiologically.

Foramen Magnum Decompression and Duraplasty in cases of Chiari malformations with syrinx is associated with good clinical and radiological outcomes. Clinical improvement occurs earlier than

radiological improvement and patients with motor dysfunction have lower recovery rates of existing neurological status as compared with other patients. The improved clinical outcomes are sustained over a period of time as measured by CCOS (Chicago Chiari Outcome Score).

Foramen Magnum Decompression and Duraplasty significantly reduces the need for second surgery in cases with syrinx. In the present study only one patient (3.3%) needed syringo-thecal shunt after Foramen Magnum Decompression.

Hence in conclusion, in cases of Chiari malformation with syrinx, Foramen Magnum Decompression and Duraplasty is alone enough, even for the management of syrinx and only small percentage of cases need a second procedure (syringo-thecal shunt).

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