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A hospital-based study of cervical rib/ribs and its association with neurological complication

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***Abstract*---Introduction**: Cervical rib is an additional rib which is the costal element of seventh cervical vertebra. Hence cervical ribs may first be revealed by nervous (particularly on eighth cervical and first thoracic spinal nerve) and vascular symptoms. Cervical rib is more often unilateral and somewhat more frequent on the right. In 90% of cases cervical rib probably causes no trouble. So the present study addresses the prevalence of cervical rib/ribs among both adult male and female and Radiological measurement of costal elements and its association with neurological involvements. **Aim**: the main aim of this study is to find out the prevalence and relation of length of costal process of 7th cervical rib with neurological symptoms among KPC Medical College outdoor patients. **Methods:** A prospective study has been carried out using technically adequate cervical spine AP and chest x rays PA view taken in department of Radiology, KPC Medical College and Hospital. **Results**: In this study all numerical and nonnumeric data of 495 patients has been plotted in Excel of Office 13. Observed 13 cases of cervical rib/ribs in which 7 were unilateral and 6 bilateral. Out of these 13 cases 12 cases had rudimentary cervical ribs. It was also observed that a feature of lower motor neuron type of neuropathy was present in 23 patients in whom 5 had cervical ribs. I have also measured length of bilateral transverse process and 8 cases were found with elongated transverse process either unilateral or bilateral. 4 cases among elongated transverse process were also

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found with neuropathy. **Conclusion**: Prevalence of cervical rib was found more among females. It was also observed that middle aged females with cervical rib's new more symptomatic which is similar in many previous studies. In this study most of the symptomatic male patients belonged to extreme age group. This fact is yet unexplored in other studies. A weal correlation was found between cervical rib and neuropathy which was our principal aim of this study.

***Keywords*---**Cervical rib, Neuropathy, Transverse process.

Introduction

Cervical rib has been an important clinical entity for about 2 centuries. Many vertebrates especially reptiles have cervical ribs as a part of their normal anatomy rather than a pathological condition. Some Sauropods had exceptionally long cervical ribs up to 4 meters long. In birds, the cervical ribs are small and completely fused to the vertebrae. In mammals the ventral parts of the transverse processes of the cervical vertebrae are the fused-on cervical ribs.

Cervical rib is an additional rib which is the costal element of seventh cervical vertebra. It may be a mere epiphysis on its transverse process, or more often it has a head, neck and tubercle. When a shaft is present, it is of variable length, and extends antero-laterally into the posterior triangle of neck, where it may end freely, or join the first rib or costal cartilage, or even the sternum. A cervical rib may be partly fibrous, and its effects are not related to the size of its osseous part. If it is long enough its relations are those of a first thoracic rib. Usually the lower trunk of brachial plexus and subclavian vessels are superior and apt to suffer compression in a narrow angle between rib and scalenus anterior. Hence cervical ribs may first be revealed by nervous (particularly on eighth cervical and first thoracic spinal nerve) and vascular symptoms. A cervical rib may show synostosis or diarthosis with either the anterior or posterior roots of the seventh cervical transverse process or, more usually, with both. Cervical rib is more often unilateral and somewhat more frequent on the right. In 90% of cases cervical rib probably causes no trouble. In the remainder complications may be neurological, vascular or local. Neurological complications include tingling along the distribution of the lower trunk of the brachial plexus i.e. along the ulnar border of the forearm and hand. In 1821, Sir Astley Cooper first described axillary subclavian artery compression due to cervical rib. Many people, especially in the middle age, the shoulders start drooping which causes the cervical rib to get depressed and leads to severe symptoms. Cervical ribs or fibrous bands are just one feature that predisposes to narrowing and compression at the outlet. Poor posture, drooping shoulders and large breasts etc. can cause the thoracic inlet to narrow and compress the neurovascular structures. Trauma at inlet, fracture of clavicle, excessive callus, hematoma or pseudo aneurysm, sleep disorder, oestrogen or thyroid deficiency, inflammatory disease including rheumatoidarthritis, fibromyalgia, kyphosis and scoliosis, thrombosis, embolism and nerve entrapment can cause this syndrome too. It is necessary to exclude thrombosis, embolism and nerve entrapment in other places. This includes

Pancoast's syndrome, where lung cancer infiltrates the brachial plexus. Paget-Schrötter syndrome is thrombosis of the subclavian vein following heavy exercise of the upper limb. X-ray, MRI and CT can distinguish cervical rib or fibrous band, elevated first ribs due to tight anterior or middle scalene muscles, displaced fractures of clavicle, non-union and excessive callus, cervical spine degenerative disease, malignant lesion in the chest, degenerative spurs, herniated discs or other causes.

So the present study addresses the prevalence of cervical rib/ribs among both adult male and female and Radiological measurement of costal elements and its association with neurological involvements.

Aim & Objective:

The cervical rib is well known entity in neurovascular complications. Compression either by bony ribs or its distal fibrous component may cause radiculopathy or compromised vascular flow through subclavian vessels. In orthopaedic outdoor I have seen numerous patients of different age group and of different socio economic group with pain in neck or shoulder region and among them few have weakness in upper limbs. Many of them responded well with conservative management only. So the main aim of this study is to find out the prevalence and relation of length of costal process of 7th cervical rib with neurological symptoms among KPC Medical College outdoor patients. In this study the presence of cervical rib/ribs is/are observed in both adult male and female population in cervical spine antero-posterior (AP) and chest x-ray postero-anterior (PA) view and respective length was measured using measuring software (RadiAnt DICOM viewer) installed in KPC Medical College Radiology Department. This study has been conducted in orthopaedic outdoor among patients having pain in cervical region. Specific object of this study:

1. Prevalence of cervical rib/ribs.
2. Sex wise prevalence rate.
3. Prevalence of complication according to age groups.
4. Prevalence of neurological complications caused by cervical rib/ribs.
5. Length of cervical rib and association with neurological problems.
6. Type of neurological problem caused by compression by cervical rib.
7. Whether wider transverse process (more than 4.5 cm), unilateral or bilateral is related with neurological complications or not.

Materials and Methods

This study was a Prospective analytical and correlation study. It was conducted in the Department of Orthopedics & Orthopedic OPD of KPCMC. Randomly selected adult male and female patients of different race and religion totally 495 adult males and females who have met the inclusion criteria. (most of them belong to eastern India) attending orthopedic outdoor or admitted in orthopedic ward having pain in their neck region without gross bony abnormality and without history of trauma over cervical region with special emphasis on patients with neurological complications in upper limbs. The duration of this study was One year from the date of acceptance of proposal i.e. 06/01/2014 to end of January 2015.

Results

In this study all numerical and nonnumeric data of 495 patients has been plotted in Excel of Office 13. Observed 13 cases of cervical rib/ribs in which 7 were unilateral and 6 bilateral. Out of these 13 cases 12 cases had rudimentary cervical ribs. It was also observed that a feature of lower motor neuron type of neuropathy was present in 23 patients in whom 5 had cervical ribs. I have also measured length of bilateral transverse process and 8 cases were found with elongated transverse process either unilateral or bilateral. 4 cases among elongated transverse process were also found with neuropathy.

Prevalence of cervical rib in our study = 13/495 ×100 = 2.62 %

Prevalence of cervical rib among females = No. of female with C ribs/ female population =7/ 198 × 100 = 3.53 %

Prevalence of cervical ribs among males = No. of males with C ribs/male population

= 6/297 × 100 = 2.02 %

So prevalence among females is higher than male.

Prevalence of bilateral cervical ribs in our study population is = 6/495 ×100 =1.21%

Prevalence of widened transverse process irrespective of symptoms: = 8/495 × 100 =1.61%

Prevalence of neuropathy due to any cause among patients who complained of neck pain

=23/495 ×100 = 4.64%

And neuropathy due to cervical rib = No. of neuropathy Pt. with C ribs/ Total Pt with neuropathy = 5 / 23 ×100 = 21.73%

Neuropathy among elongated transverse process Is = 4 / 8 × 100 =50 %

And among all patients with neuropathy it is = 4 / 23 ×100 = 17.39 %

Prevalence of elongated transverse process in female = 3/198 × 100 = 1.51%

And same in males = 5/297 × 100 = 1.68%

Now to find out the association between cervical ribs and neuropathy I have taken help of cross tabulation to find out Odds ratio—

C Rib * Neuropathy Cross tabulation

Count		Neuropathy		Total
		No	Yes	
C Rib	No	464	18	482
	Yes	8	5	13
Total		472	23	495

For accuracy of Odds ratio, 95% confidence interval needs to be measured.

Correlation			
	Value (ODDS RATIO)	95% Confidence Interval	
		Lower	Upper
Odds Ratio for C Rib (No / Yes)	16.111	4.792	54.164
For cohort Neuropathy = No	1.564	1.017	2.405
For cohort Neuropathy = Yes	0.097	0.043	0.221
N of Valid Cases	495		

Now Odds ratio is 0.097, close to 0 and lies between 95% confidence interval. So a weak correlation presents between presence of cervical rib and neuropathy.

TABLE FOR NO CERVICAL RIB

Descriptive Statistics[a]

	N	Minimum	Maximum	Mean	Std. Deviation
Sl No	482	1	495	251.07	141.785
Left	0				
Right	0				
Rt TP	482	20	46	36.33	2.866
Lt TP	482	22	47	35.97	2.873
Length of C7 TR Process (mm)	482	47	93	72.29	5.353
Valid N (list wise)	0				

a. C Rib = No

Among patients with no cervical rib I have measured length of transverse process.
Mean length of Rt T P =36.33 mm(SD =2.866)
Mean length of Lt T P =35.97 mm (SD =2.873)
So patients with no cervical rib right transverse process is lengthier than left one.

TABLE FOR CERVICAL RIB

Descriptive Statistics[a]

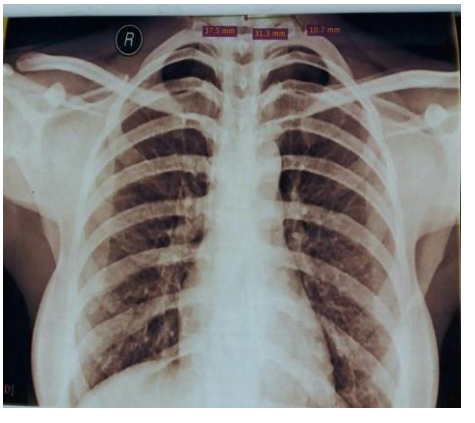
	N	Minimum	Maximum	Mean	Std. Deviation
Sl No	13	4	470	134.00	148.396
Left	10	8	18	12.10	2.767
Right	9	8	38	14.78	8.969
Rt TP	13	30	46	35.38	4.350
Lt TP	13	31	44	36.15	3.648
Length of C7 TR Process (mm)	13	63	90	71.62	7.159
Valid N (list wise)	6				

a. C Rib = Yes

Now in patients with cervical rib I have measured the same and found
Mean length of Rt T P = 35.38 mm(SD =4.35)
Mean length of Lt T P =36.15 mm (SD =3.64).
There are some peculiarity noted in patients with cervical rib i.e. left sided transverse process is lengthier than the right one.
To find out relative risk of neuropathy in elongated transverse process-

Risk factor	Presented with neuropathy	No neuropathy
Elongated TP	4	4
Normal TP	19	472

Relative risk of having neuropathy in elongated TP = 4×491 / 19× 8 =12.92
So patients with elongated transverse process have 12.92 times higher chances of having symptoms. But a confounding factor, presence of cervical rib is present. Neuropathy what I documented in patients with elongated transverse process may be actually due to simultaneous presence of cervical rib in few cases.



Discussion

This project was carried out in KPC Medical college, mainly at orthopaedic outdoor in association with the department of radiology of this college. Total 495 samples including 297 Males and 198 Females. found cervical ribs in 13 subjects in which 12 were rudimentary. Among these 12 cases 7 were unilateral and 5 were bilateral rudimentary ribs. In one case unilateral fully developed cervical rib and rudimentary on other side is found in our survey. None of these cases including the complete one did show severe neurovascular compression or muscle wasting or paralysis. But some degree of neuropathy with pain has been detected in 4 cases which evaluated by the help of muscle tone and tendon jerks of upper limb muscles. Some degree of hypotonia and hyporeflexia was noted in these 4 cases. During this study, found 18 more patients with features of lower motor palsy in form of hypotonia and hyporeflexia which are not associated with cervical ribs. Overall prevalence of cervical ribs in this study population was 2.62% in which 1.21% cases cervical ribs were bilateral. Among the 13 cases of cervical rib only 1 was complete rib (7.7 %) and 12 (92.3 %) cases were rudimentary ribs. Out of this 13 cases 5 cases were associated with neurological complications. In our study population total 23 patients (4.64%) out of 495 patients are found with neurological problems. So among patients with neurological symptoms only 17.39% was due to cervical ribs. Several studies have been done in different population to know the prevalence of cervical ribs and its association with neuropathy.

In 1999 a study in the department of anatomy, Gazi University among 6630 patients in which 3543 were female and 3087 were male. Founded 144 cases of cervical ribs among female and 55 among males. The incidence rates was 3% among the male/female 1:3. They found unilateral incomplete cervical rib incidence was two times higher in females compared to males, bilateral incomplete rib was three and half times higher in females. The most frequent cervical rib was bilateral incomplete type among female. The unilateral cervical rib was noticed more frequent on right side. In present study the prevalence of cervical rib 2.62%. Prevalence among female is 3.53% whereas among males it is 2.02 %. The overall prevalence rate in this present study with Anatolian population. In our study prevalence of cervical rib among females is higher than males but not as high as shown in previous study. In males it is common on right side (3 out of 3). No relation with neurological symptoms with Anatolian study. [55]

In John Hopkins University a retrospective study was conducted in 2012 focusing on prevalence of cervical ribs in CT scan done in-between November 09 to May 11. They had 3404 samples, cervical ribs were found in 2.0% (67/3404). The study included 1414 (41.5%) women and 1990 (58.5%) men. Women were found to have cervical ribs more than twice as often as men, 2.8% (39/1414) versus 1.4% (28/1990). 94 cervical ribs in 67 patients were found. Moreover, 59.7% (40/67) of patients with cervical ribs had a unilateral rib, while the remaining 40.3% (27/67) of patients had bilateral cervical ribs. The result is comparable with present study. Though sample size is less (495) in comparison to this present study but prevalence appears to be little higher (2.62%). Females were found more with cervical ribs (53.84%) than males (46.15%). Out of 13 cases with

cervical ribs 46.15% is (6/13) bilateral and 53.84% (7/13) is unilateral. In this study no emphasis on clinical aspect is given. [61]

In AIIMS Raipur study to find out the prevalence of cervical ribs in people of Central India and its association with gender, body sides, handedness and other thoracic bony anomalies. They found 61(1.22%) persons with cervical rib among 5000, out of which 22 (0.44%) bilateral and 39 (0.78%) unilateral so statistically there was a little unilateral predominance. Overall and unilateral incidences were little more common in males (M-0.68%: F-0.54% and M- 0.48% : F-0.3%) whereas bilateral incidence was little more common in females (M-0.2 : F-0.24), Unilateral cases showed little predominance towards males and left sides but statistically it was not evident. Among 61 persons with cervical rib only 3 were left handed and rest right handed. All 3 left handed (1 male and 2 females) presented cervical rib on their right side, so association of cervical rib with the handedness was also statistically insignificant. Any association between the presence of cervical rib and other thoracic bony anomalies could not be established except parallel finding of 'elongated transverse process of 7th cervical vertebrae' in 2 cases with right sided cervical rib and 'thoracic scoliosis' in other 2 cases, one with bilateral and other with left sided cervical rib. In our study though prevalence came higher (2.62%) but prevalence of unilateral rib is more as seen in this study. I have not incorporate handedness in my study but measured the length of respective transverse process from tip of the spine of C7. Theoretically length of transverse process of one side more than 4.5cm is considered as elongated transverse process. It was seen that out of 5 cases of symptomatic cervical ribs 1 patient had elongated transverse process. Overall prevalence of elongated transverse process is 1.61%. Assessment of neuropathy also not done in this study.[60]

Another prospective study conducted in Saudi Arabia among population of 1000 patients in which 490 were male and 510 were female. The study was reported normal in 736 patients (376 males and 360 females). Cervical ribs were found in 34 patients, constituting a prevalence of 3.4% of study population. The female to male ratio was 2.1:1, a female predominance consistent with the literature. Cervical ribs were bilateral in 41%, right-sided in 32.3%, and left sided in 26.7%. Of the 20 patients with unilateral cervical ribs, 15 (75%) had associated elongated transverse processes contralateral to the cervical rib. Two hundred and thirty patients had an elongated transverse process, giving an overall prevalence of 23%. The female to male ratio was 1.18:1 showing a female predominance consistent with the literature. Of these 230 patients, 128 patients (55.6%) had bilateral anomalies, while 70 patients (30.4%) have elongated left transverse processes; the remaining 32 patients (14%) have an elongated right-sided elongated transverse process. In my study the prevalence is low (2.62%) but this may be due to criteria of selection of patients. In Saudi study they took adequate adult X ray of 1000 patient without putting any emphasis upon symptoms of the patients, whereas we have taken patients with pain in cervical region only. 53.14% cases were unilateral among which 57.14% (4/7) were female and rest were male. Overall more female prevalence in both these studies are comparable. Unilateral rib was more (71.42%) among female patients with cervical ribs. Total 8 cases (prevalence 1.61%) of elongated transverse process had been noted which is pretty low in comparison to the Saudi study population.[33]

A second study was found based on Saudi population by Al Zahrani et al,20 that described the prevalence of elongated transverse processes and cervical ribs in the Saudi population. It was a prospective study conducted in Makkah, Saudi Arabia more than 14 years ago. Of 1,300 chest radiographs of patients attending the outpatient clinics, cervical ribs were found in 25 (1.9%), 76% were bilateral, and 74% in females. Of these, 9 were symptomatic. Neurogenic compression was demonstrated in 9 and vascular compression in the other 2, and the authors concluded that radiologists and physicians should be cognisant of the higher prevalence of symptomatic cervical rib in the Gulf region. Prevalence in my study is higher than this study but bilateral cases were only 46.15% and 53.84% were unilateral. 53.84 % (7/13) females were having cervical rib/ribs. But neurological problems among patients with cervical rib was 38.46% (5/13) in my study matches with the previous one 36% (9/25).[65]

Era medical college conducted a study in year 2011 for a period of 7 months and they evaluated chest X ray of 12950 patients with different complains and found an incidence of cervical rib of 0.6% with bilateral cervical rib being more common in both males and females and the incidence of cervical rib in females was 0.73% as compared to 0.49% in males. No neuropathy was evaluated in this study. But overall prevalence as I found is much higher in our study group. This is due to the fact that they have not specified the symptom of the patients as I have done in my study which revealed there is association(ODD RATIO 0.097,LOWER LIMIT OF 95% CONFIDENCE INTERVAL =0.043,UPPER LIMIT =0.221) between cervical rib and pain in cervical region, more precisely lower motor type of neuropathy. [34]

The study conducted in department of radiology, Jos university teaching hospital, PMB 2076, Jos and in department of radiology, university of Maiduguri Teaching Hospital, Maiduguri on cervical rib variant in a Nigerian population found prevalence of cervical rib is 0.7% (9 patients out of 1384 subjects). A higher occurrence was found in females with five cervical ribs (55.6%) and sex specific prevalence of 0.7% compared to males with four cervical ribs (44.4%) and sex specific prevalence of 0.6%.This study showed much lower prevalence than my study but females were more found with cervical ribs in both these studies. Measurement of transverse process were not done, neither their correlation with neuropathy in this study.[12]

“Frequency of cervical ribs in the Urhobo population” a study conducted in delta university, Abraka, Nigeria The table above reveals a prevalence of 0.6% (3/500) was found out from the study. The prevalence for males is 0.4% (1/245) and 0.78% (2/255) was recorded for females. Of the three radiographs with cervical ribs, one was found on the right, the other on the left and last was bilateral. Sample size is almost same but prevalence is too low. It seemed that Nigerian population have pretty less prevalence of cervical rib.[64]

A London based study to see the prevalence of cervical rib in London population reviewed 1,352 chest radiographs of mixed sex and ethnicity. This study found that the overall prevalence of cervical ribs was 0.74% with a higher rate in females compared with males (1.09 and 0.42%, respectively). Of the 10 individuals with a cervical rib, five were on the left, three were on the right and two were bilateral. The presence of elongated C7 transverse processes (transverse apophysomegaly)

was also noted. Found a total of 30 elongated transverse processes with an overall prevalence of 2.21%. They were also more common in females (3.43%) than males (1.13%). In London population prevalence of wider transverse process is higher (2.21%) than study population (1.61%). Wider or elongated transverse process among females in my study was 1.51% and in males 2.52% which is just opposite what found in above study.[7]

A large study was conducted looking at the incidence in White British with direct comparison to the Asian population. A total of 1545 consecutive cervical spine radiographs performed for any reason were collected and reviewed. 5.9% of White British and 24.9% of Asian patients had evidence of cervical rib. This was statistically significant ($p<0.0001$, $x2$ test). Asians are 5 times more likely compared to White British to have cervical rib. Here study design is different, cross sectional study intending for incidence. Now it is difficult to compare the outcome with my study which is Prospective analytical and correlation study. Moreover I have not compared between two populations. Being a part of Asia, one inference can be drawn, that is prevalence which is too high in comparison to any other Asian study or even study on world population.[9]

In Mc gregor's textbook this anomaly stated to be present in less than 0.5% population, but more often it is incomplete one. Cervical rib is more often unilateral and somewhat more frequent on the right. In 90% of cases, cervical rib probably causes no trouble. It is also found the unilateral prevalence is more (53.84%) and 57.14% belong to right side as stated in the text book.[3]

In another text book by John Ebnezer, incidence was reported 0.46%.Nearly 50% of those are unilateral. It is more common on right side. And this statement matched well with my observation except the incidence which is 5 times higher in my study. It was also observed that mean age of females presented in orthopedic clinic with neck pain was 46 years which is nicely explained here that pronounced drooping of shoulder in women after middle age, trauma, unusual lifting operation, acute illness that makes muscle weak, pulling the plexus and artery distally giving rise to symptoms.[13]

American society of neuroradiology conducted a study upon 3404 patients in which cervical ribs were found in 2% (67 patients).The study included 1414 (41.5%) women and 1990 (58.5%) men. Moreover 59.7% of patients with cervical ribs had a unilateral rib, while the remaining 40.3% of patients had bilateral cervical ribs. Prevalence matched closely with my study. Now in female population of my study incidence of cervical rib was 3.53% and among males it was 2.20%; much less than females. The same observation was given by John Hopkins University in their CT scan based study.[52]

A Chennai based study done on 1500 samples over a period of 2 years revealed 22 cases with cervical rib. Out of this 22 cases, in 20 cases it was unilateral and only in two cases it was bilateral and the incidence of cervical rib was found to be 1.16% in this study. Result of this study did not match with all other previous study. Even prevalence was found lower by 1.5% approx. than my study. 9.09% cases of cervical rib were symptomatic in their study where as 38.46% patients

with cervical rib showed some features of lower motor neuropathy in my study.[66]

A study conducted in Pakistan not intended to see the prevalence of cervical rib but to find out the association between elongated transverse process and neuropathy hence it is discussed here. 160 cases included in this study.. In this study prevalence of elongated transverse process was much less (1.61% only) but their relative association with neuropathy was much higher i.e. about 12.92 times.[10]

Lastly a cadaveric study mentioned in Atlas of anatomy which showed cervical ribs occur in about 0.5-1% of cadavers. They tend to be small but occasionally reach the sternum. The ventral extremity may (a) lie free above or between the scalene muscles, (b) be connected to the sternum by a ligamentous prolongation, (c) articulate with the superior surface of the first thoracic rib, or (d) form a complete rib that articulates with the sternum. Because of their location, cervical ribs may cause a disturbance to the vascular or nerve supply to the arm, forearm, and hand. Double cervical ribs have been reported. A cervical rib may pierce scalenus medius. Mostly enlighten the theoretical aspect of cervical rib but incidence rate matched with several other studies.[62]

Conclusion

Our study aimed at occurrence of cervical rib in KPC Medical College, orthopedics outdoor population who have presented with neck pain and to find out their association with neuropathy. In this process we have collected data from 495patient, agreed to include them in our study with proper consent were evaluated. A total 13cases with cervical rib were found in which 6 were bilateral and 7 were unilateral. Only1casewith unilateral complete rib found. On comparison with different literatures, studies across the world we found prevalence of this bony abnormality varies from 0.5 to 3%,in my study it was 2.62%. Prevalence of cervical rib was found more among females. It was also observed that middle aged females with cervical rib's new more symptomatic which is similar in many previous studies. In this study most of the symptomatic male patient's belonged to extreme age group. This fact is yet unexplored in other studies. A weak Correlation was found between cervical rib and neuropathy which was our principal aim of this study. Another parallel finding emerged from this study was prevalence of elongated transverse process, a highly neglected chapter. Only one elongated transverse process and their role in causation of neuropathy. Anyhow in our study the prevalence of the same came less, only1.61%. But on assessing their role in neuropathy the relative risk came13.63 which is more. After all this discussion of different association of pain, some inference must be drawn without which this healing science will be an unsolved puzzle. More than 99% patients were asymptomatic and only 0.8% presented with mild lower motor type of neuropathy which responded well with conservative management.

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