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Torg ratios based on cervical lateral plain films in normal subjects

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ABSTRACT

Stenosis of the spinal canal can be caused by trauma, degenerative processes, and tumors, causing a neurological deficit. If the neurological deficit could be detected or diagnosed earlier, the late complications such as quadriparesis could be prevented. The Torg ratio can be used to find evidence of cervical canal stenosis on lateral plain film, as it has the advantage of not being affected by magnification. The purpose of this study was to determine the Torg ratio for normal subjects using lateral plain films of cervical vertebrae. This cross-sectional study was done at the Department of Radiology FKUI/RSUPN-CM Jakarta, starting from September 16 – 20, 2008. The study included 98 subjects, aged 20 – 40 years, were the mean age of the subjects was 27.4 years (SD ± 5.4). All participants were subjected to measurement of the Torg ratio by cervical lateral plain film. The mean Torg ratio of normal subjects was 0.99 for males and 1.06 for females. The mean Torg ratio of several ethnicities were 1.04 for Javanese, 1.02 for Sundanese, 1.01 for Betawi, and 0.99 for other ethnicities. The mean Torg ratio of our subjects is different from that of other people, such as Pakistanis, Singaporeans, and Koreans. The mean Torg ratios of ethnicities are not significantly different from one another. Therefore, the Torg ratio can be relied upon to predict narrowing of the cervical spinal canal in the sagittal plane.

Keywords: Measurement, cervical lateral plain film, Torg ratio

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INTRODUCTION

The bodies of the cervical vertebrae are smaller in size compared with those of other vertebrae and function to protect the spinal cord, support the head, and allow movement of the head (in flexion, extension, and rotation). The cervical vertebrae consist of 7 bones, two of which, i.e. cervical vertebrae 1 (C1) and 2 (C2), are different in form compared to the other five. The cervical canal, which is situated posteriorly to the vertebral body, has an almost cylindrical shape, and within it are the spinal cord running along C1-7, and the brachial plexus, which passes outwards at C5-6. Stenosis, or narrowing, of the spinal canal has been previously associated with neurologic injury. The spinal canal-to-vertebral body ratio,

or Torg ratio, is one method used to determine the presence of spinal stenosis.[1-3] Cervical canal stenosis may cause a neurological deficit, with neck stiffness as the earliest symptom. If the deficit increases in severity, or treatment is delayed, there will be neck pain radiating to the shoulder and down the arm, corresponding to the distribution of the affected nerve root.[4] Because of the possibility of a serious negative impact due to delayed treatment, this condition has to be detected as early as possible. If the potential for a neurological deficit can be detected in its early stages, risk management for quadriplegia may be avoided.

Torg et al.[5] have introduced a ratio called the Torg ratio (spinal canal-vertebral body ratio), that is not affected by magnification, and is measured on lateral plain films of cervical vertebrae. This measure is a ratio determined by the distance from the center of the posterior aspect of the vertebral bodies C3-C7 to the spinal laminar line (the diameter of the spinal canal) divided by the anteroposterior diameter of the vertebral body anterior to the canal. A ratio of $\geq$ 1.0 signifies absence of stenosis of the spinal canal, but a ratio of $\leq$ 0.8 indicates the presence of cervical spinal canal stenosis. Suk et al.[6] from Korea determined the Torg ratio of the cervical vertebrae (C3-C7) of 90 normal Korean adults (without any abnormality of the cervical vertebrae) and found mean ratios of 1.02 for females and 0.9 for males. A study of Torg ratios conducted in Pakistan in 100 males and females, yielded an almost identical result as in the Korean study, with mean ratios of 1.08 for females and 0.95 for males.[7] Both studies used a sample of dried human bone specimens for direct measurement of spinal canal diameter and anteroposterior diameter of the vertebral body.

Lim et al.[8] state that the sagittal diameter of the cervical spinal canal and the size of vertebral body are different in females compared with those in males. This study was conducted with a sample size of 80 males and females of various ethnic groups in Singapore, using Torg ratios measured on cervical lateral plain films, resulting in a mean ratio of 0.9 in males and 0.99 in females. The anthropometric structure of Indonesians differs from that of Americans, Japanese, Pakistanis, Europeans, as well as Koreans, necessitating determination of the normal Torg ratios specifically for Indonesians as indicator of the presence of spinal canal stenosis.[6-8]

Radiology has a substantial role in assessment of spinal canal stenosis, starting with plain films, and proceeding to the more sophisticated radiological modalities. The plain film has a strong potential for playing a role in assessment of spinal canal stenosis. A survey in the United States reports that the vertebral plain film has become a routine procedure (96%) in patients with severe blunt trauma and the standard for investigation of acute trauma of the vertebrae. The cross-table lateral plain film has a specificity of up to 97%, whilst its sensitivity is up to 96% in acute fracture due to cervical trauma, when compared with the CT scan.[9,10] The cross-table lateral plain film may be used for indicating spinal canal stenosis in traumatic as well as nontraumatic cases, but direct measurement of the spinal canal (based on the distance from the midpoint/center of the posterior aspect of the vertebral body to the spinal laminar line) is considerably affected by the magnification factor, due to differences in focus-to-film distance. It was reported that a difference in focus-to-film distance between 1 and 1.5 m will change the size of the spinal canal by 0.5 cm, thus in this case the Torg ratio is a better measure.[11]

The plain film is a standard radiological modality present in all hospitals in Indonesia and the cost is relatively low. In trauma patients in whom assessment of the spinal canal is necessary for rapid detection of cervical canal stenosis, the Torg ratio is used. In developing countries such as Indonesia not all hospitals have radiological modalities such as computerized tomography and MRI.

To date there are no definite Torg ratios for Indonesians for determining the presence of spinal canal stenosis resulting in neurological deficits. Based on this fact, the investigators conducted the present study with the objective of ascertaining the Torg ratio in normal subjects, by studying the cervical lateral plain film.

METHODS

Research design

The research was designed as an observational cross-sectional study.

Subjects

Volunteer subjects were recruited from the Department of Radiology, Cipto Mangunkusumo Hospital, Jakarta from September 16 – 20, 2008. The inclusion criteria were: (i) individuals with inactive epiphyseal growth centers and without neurological manifestations, such as neck pain or paresthesia associated with movement of the neck; loss of sensibility corresponding to a dermatome; muscular weakness and atrophy; (ii) and on cervical lateral plain film: normal position of the cervical vertebrae, without evidence of listhesis; no evidence of osteophytes on the vertebral bodies (or only minimal osteophytic growth); no evidence of lytic or blastic lesions or fractures; no evidence of intervertebral disc compression; and intact pedicles. Subjects who reported a history of cervical spine injury were excluded from the study.

Data collection

Data collection in this study was performed at the Department of Radiology, Cipto Mangunkusumo Hospital, Jakarta. The vertebrae assessed consisted of the cervical vertebrae 3 to 7 (C3-C7). C1 and C2 were not included because of their different shape compared with the other cervical vertebrae, and also because cases of cervical stenosis are more common between C4 – C6.[7,8]

The measurements of the cervical spinal canals and vertebral bodies were taken as described above and the Torg ratio for each cervical vertebra was calculated by dividing the diameter of the spinal canal by the anteroposterior diameter of the corresponding vertebral body.[6] For consistency of results, the measurements were performed by a single investigator with the same measuring instrument.

Statistical analysis

Independent Student's t-test and analysis of variance (ANOVA) were conducted to determine if significant differences existed among the selected variables. The Statistical Package for the Social Sciences (version 15.0, SPSS Inc, Chicago, IL) was used for all statistical analyses. All statistical analyses were conducted in the null form, and the alpha level of 0.05 was determined a priori as statistically significant.

RESULTS

A total of 98 volunteers were willing to participate in this study and among these subjects there were more males than females, namely 58 males (59.2%) and 40 females (40.8%). The youngest subject was 20 years old and the oldest 39 years, while the mean age of the subjects was 27.4 ± 5.4 years.

The Torg ratio

The results of the measurement of the midsagittal diameter of the spinal canal and the anteroposterior diameter of the cervical vertebral bodies C3 to C7 in males and females, and the calculated Torg ratio may be seen in Table 1. In males the mean Torg ratio was 0.99 and in females 1.06. To find a difference in Torg ratios between males and females, the investigators performed the t-test, and found that the mean Torg ratio was not significantly different between males and females ($p = 0.577$).

Table 1. Mean values of cervical variables according to gender

Gender	Canal	Body	Torg Ratio	p
Male (n=58)	1.88	1.89	0.99	0.577
Female (n=40)	0.99	1.82	1.06	

Table 2. Mean values of all cervical variables according to occupation

Occupation	Canal	Body	Torg ratio	p
Physicians+	1.89	1.80	1.05	0.662
Employees+	1.84	1.79	1.04	
Drivers+	1.88	1.87	1.01	
Housewifes	1.77	1.73	1.04	

Calculation of mean Torg ratios associated with occupation was also performed for cervical vertebrae C3 to C7, the results of which can be seen in Table 2. In physicians and students the mean Torg ratio was 1.05, in workers and employees 1.04, in drivers / security / cleaning service personnel 1.01, and in housewifes 1.04. Differences in Torg ratios between occupations were tested by ANOVA. From the ANOVA results it was found that the mean Torg ratios were not significantly different between occupations ($p = 0.662$).

The difference of mean Torg ratio by ethnicity may be seen in Table 3. In Javanese the mean Torg rato was 1.04, in Sundanese 1.02, in Betawi 1.01, and in other ethnicities 0.99. To find a difference in mean Torg ratios between ethnic groups, the investigator performed ANOVA and found that the mean Torg ratio was not significantly different between ethnic groups ($p=0.421$).

The differences of mean Torg ratio by age group may be seen in Table 4, where in the age group below 25 years the mean Torg ratio was 1.03, in the age group 25-30 years 1.05, in the age group 31-34 years 1.03, and in the age group over 35 years 0.96. ANOVA testing yielded a significant difference in Torg ratios between age groups ($p<0.05$). The mean Torg ratio was greatest in the age group over 35 years.

Table 3. Mean values of all cervical variables according to ethnicity

Ethnicity	Canal	Body	Torg ratio	p
Javanese	1.88	1.80	1.04	0.421
Sundanese	1.81	1.77	1.02	
Betawi	1.87	1.86	1.01	
Other ethnicities	1.85	1.86	0.99	

Table 4. Mean values of all cervical variables according to age group

Age group	Canal	Body	Torg ratio	p
< 25	1.86	1.82	1.03	0.038
25 – 30	1.89	1.81	1.05	
31 – 34	1.90	1.80	1.07	
35+	1.74	1.84	0.96	

DISCUSSION

Cervical canal stenosis is a disorder that may cause neurological deficits, commonly resulting from cervical trauma in hyperextension or hyperflexion as well as in axial loading. The signs and symptoms of neurological deficits may be in the form of sensory or motor impairment, which if not detected promptly will cause more severe neurological deficits.[10-12]

A number of investigators have conducted various studies to detect the presence of cervical stenosis by simple measurement of the cervical canal diameter using cervical lateral plain film.[7] However, the existence of these various reports giving different cervical canal diameters resulted in several different normal ranges.[7,9] In contrast, the spinal canal to vertebral body ratio introduced by Torg et al.[5] is not affected by magnification, and is measured on lateral plain films of cervical vertebrae. A ratio of ≥ 1.0 signifies absence of stenosis of the spinal canal, but a ratio of ≤ 0.8 indicates the presence of cervical spinal canal stenosis. A study on 14 male subjects aged 24.4 ± 2.5 years found a Torg ratio of less than 0.80 in at least one vertebral level in 93% of subjects. These differences can be attributed to the fact that the latter study used MRI in determining measurements.[1] The Torg ratio for diagnosis of stenosis of the cervical canal has been used by many researchers[12,13] with the objective of providing reference values for use by clinicians in diagnosis of cervical canal stenosis.

The various methods used by these investigators for assessing the Torg ratio were lateral plain film,[4] CT scan and MRI in living subjects as well as cadavers,[7,14] and direct measurement on dried bony specimens.[7] To date no studies had been conducted on the Torg ratio in Indonesia. In our study we measured the Torg ratio in normal subjects with a total of 98 individuals, consisting of 58 males and 40 females, using cervical lateral plain film.

In our study the mean Torg ratios for males and females were 0.99 and 1.06, respectively. The results indicate the existence of differing values, the Torg ratio in Indonesian males being larger than that of Pakistani males (0.95), whereas Indonesian females have a lower Torg ratio compared with that in Pakistani females (1.08).[8] The mean Torg ratio of Indonesians is also larger compared with that of Korean males (0.93) and females (1.02)[4] and that of Singaporean males and females (0.90 and 0.99 respectively).[8]

Because our subjects, particularly those living in Jakarta, come from various ethnic groups, we also did a comparison of the mean Torg ratio on the basis of ethnicity. The mean Torg ratios of various ethnicities are listed in Table 3. After performing ANOVA to find a difference in mean Torg ratio between ethnic groups, it was found that there was no significant difference between these groups. This indicates that the ethnic groups participating in this study represent a homogeneous population.

Using ANOVA, the mean Torg ratios based on age group showed a significant difference. The variable apparently causing the difference was the mean diameter of the cervical canal in the age group of 35 years, which turned out to be narrower in comparison with the other age groups. This may be due to the smaller size of the sample in the 35 year age group and its poor homogeneity. In this study the investigators did not use the Tukey nor Shaeffer tests for finding the cause of the difference, because of the purely descriptive nature of this study.

One limitation of our study is that it included a small number of normal subjects. We analyzed 98 normal subjects, so we acknowledge that it is difficult to generalize the results to the entire Indonesian population. Another limitation of this study is its clinical relevance because radiographs are less sensitive as a screening mechanism than MRI.

CONCLUSIONS

In normal subjects there was no difference in Torg ratio between genders. However, the Torg ratio was significantly different between younger and older age groups, where subjects in older age groups had a lower Torg ratio. Therefore, the Torg ratio can be relied upon to predict narrowing of the cervical spinal canal in the sagittal plane.

REFERENCES

1. Tierney RT, Maldjian C, Mattacola CG, Starub SS, Sitler MR. Cervical spine stenosis measures in normal subjects. J Athl Train 2002;37:190-3.
2. Ilyas M. Dislokasi Interfasetal Bilateral. [Bilateral Interfacetal Dislocation]. J Med Nus 2005;24: 127-34.
3. Baehr M, Frotscher M. Topical Diagnosis in Neurology 4th ed. Thieme: Stuttgart; 2005.
4. Pavlov H, Torg JS, Robie B, Jahre C. Cervical spinal stenosis: determination with vertebral body ratio method. Radiology 1987;164:771–5. Cited by Tierney RT, Maldjian C, Mattacola CG, Straub SJ, Sitler MR. Cervical spine stenosis measures in normal subjects. J Athl Train 2002;37:190–3.
5. Torg JS, Corcoran TA, Thibault LE, Pavlov H, Sennett BJ, Naranja RT Jr, et al. Ccervical cord neurapraxia: classification, pathomechanics, morbidity, and management guidelines. J Neurosurg 1997;87:843-50.
6. Suk KS, Kim KT, Lee JH, Lee SH, Kim J, Kim JY. Reevaluation of the Pavlov ratio in patients with cervical myelopathy. Clin Orthopaed Surg 2009;1:6-10.
7. Maqbool A, Athar Z, Hussain L. Midsagittal diameter of cervical spine and Torg's ratio of the cervical spine in Pakistanis. Pak J Med Sci 2003; 19:203-10.
8. Lim JK, Wong HK. Variation of the cervical spinal Torg ratio with gender and ethnicity. Spine 2004;4:396–401.
9. Nadalo LA. Spinal stenosis. Available at: http:// www.emedecine.com. Accessed September 2, 2009.
10. Bailes GE, Petschauer M, Guskiewicz KM, Marano G. Management of cervical spine injutries in athletes. J Athl Train 2007;42:126-34.
11. Rao RD, Currier BL, Albert TJ, Bono CM, Marawar SV, Poelstra KA, et al. Degenerative cervical spondylosis: clinical syndromes, pathogenesis, and management. J Bone Joint Surg Am 2007;89:1360-78.
12. Prasad SS, O'Malley M, Caplan M, Shackleford IM, Pydisetty RK. MRI measurements of the cervical spine and their correlation to Pavlov's atio. Spine 2003;28:1263-8.
13. Kelly JD, Aliquo D, Sitler MR, Odgers C, Moyer RA. Association of burners with cervical canal and foraminal stenosis. Am J Sports Med 2000; 28:214-7.
14. Koyanagi I, Iwasaki Y, Hida K, Akino M, Imamura H, Abe H. Acute cervical cord injury without fracture or dislocation of the spinal column. J Neurosurg 2000;93:15-20.