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Research Article

MRI of Paraspinal Muscles in The Lumbar Spine: Association of Muscle Atrophy with Spinal Stenosis and Disc Herniation. A Prospective Study

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Keywords
- Paraspinal muscle atrophy
- Spinal stenosis
- Disc herniation pattern
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Abstract

Objective: To determine the association of lumbar paraspinal muscle atrophy with lumbar disc herniation and spinal stenosis.

Material and methods: Prospective study of 160 consecutive patients was done who presented with lower back pain and had disc herniation on MRI lumbar spine. Disc herniation with its pattern and spinal stenosis with its grade were analyzed. Paraspinal muscle atrophy of Multifidus, Longissimus and Iliocostalis was noted at each level of disc herniation and spinal stenosis and their correlation with muscle atrophy grade and laterality was studied.

Results: 79% patients with disc herniation showed Multifidus muscle atrophy however no significant association was seen between paraspinal muscle atrophy and disc herniation (P=.15). Significant correlation was seen between muscle atrophy laterality and disc herniation pattern (P< .001). 90% patients with spinal stenosis showed paraspinal muscle atrophy. Significant association was also seen between paraspinal muscle atrophy and spinal stenosis of any grade (P< .001).

Conclusion: There is correlation between paraspinal muscle atrophy and spinal stenosis. Pattern of disc herniation and symmetry of paraspinal muscle atrophy also has significant correlation but more studies need to be done with large sample size.

ABBREVIATIONS

MRI: Magnetic Resonance Imaging

INTRODUCTION

Lower back provides support to the upper body weight and plays a role in the mobility and stability of different parts of body. The lower back paraspinal muscles help in movement of hips when walking in addition to providing stability to the spine [1].

Two important muscles of lower back are erector spinae and multifidus. Erector spinae consists of three muscles out of which longissimus and iliocostalis play a role in lower back stability. Longissimus occupies the central position of erector spinae. The origin of its fibers is from the accessory process as well as the medial half of the posterior surface of the transverse process of each of the five lumbar vertebrae. The lateral most component of erector spinae is iliocostalis. The origin of its lumbar fibers is from the tips of the first four lumbar transverse processes and the posterior surface of the middle layer of thoracolumbar fascia lateral to these tips. These fibers insert into the medial end of the iliac crest and the dorsal segment of the iliac crest along with the fascicle. The function of thoracic and lumbar components of erector spinae is the extension of the vertebral column and when acting unilaterally they can laterally flex the trunk [2].The multifidus muscle is the back muscle which is medial most in location. It is also the largest muscle spanning the lumbosacral junction. Its function is to maintain the erect posture of the trunk and also abduction and rotation of the trunk [3]. The origin of Multifidus is in the form of fascicles arising from the lower edge of the lateral surface of the spinous process and from the lower end of its tip. These fibers course caudally to their insertion into the transverse elements of vertebrae which are two, three, four and five levels below. Fascicles that extend beyond the fifth lumbar vertebra insert into the dorsal surface of the sacrum. The longest fascicles from the first and second lumbar vertebrae insert into the dorsal segment of the iliac crest [2].

Lower back pain is becoming more prevalent day by day and according to an estimate it affects 65–85% of the general population at some point throughout their lifetime [4]. Low back pain causes a lot of disability hampering day to day activities. It is prevalent in people belonging to all cultures and interferes with overall quality of life also affecting performance at work. It is also one of the most frequent causes for medical consultations. The low back pain is an issue faced by many people on daily basis. It

commonly occurs among the masses yet poses serious questions for the physicians. It is a cause for social as well as economic problems. According to an estimate lower back pain is present in about 12% of Pakistani population [1].

One of the most common causes of lower back pain in adult population is herniation of lumbar disc. It is also a frequent cause of sciatic pain in adults. The protruded disc causes compression on the dorsal and/or the ventral nerve roots leading to low back pain and other symptoms such as sciatica, muscular spasm, and restricted trunk movements [3]. Likewise lumbar spinal stenosis is another important cause of backache and becomes more common with increasing age and seen frequently in elderly people. Spinal stenosis patient can present with neurologic deficit pain or disability [5].

Young to middle aged population is affected by lower back pain secondary to degenerative disc disease. Its peak incidence occurs at approximately 40 years of age. If radiologic evidence of lumbar disc degenerative disease is considered, disc degeneration becomes more prevalent with age. When disc degenerative disease was studied as a cause of back pain it was found to affect men more than women. Patients having lumbar disc degenerative disease can present with symptoms of sensory disturbances in legs, claudication and pain relief upon bending forwards [6].

Magnetic Resonance Imaging (MRI) is increasingly applied in finding out the underlying cause for back pain. It plays a role as a diagnostic tool in patients with lower back pain for evaluation of underlying anatomical pathology. It can also provide valuable information about muscle quality, atrophy or other contributing factors including herniated disc, spinal stenosis or compression of the nerve roots. In recent studies the importance of fatty infiltration of lumbar paraspinal muscles and their size (cross sectional area or volume) has been highlighted as a tool in helping to predict the disability related to lower back pain, chances of recurrence of symptoms and whether the symptoms would improve with exercise or not. Magnetic Resonance Imaging (MRI) is frequently used in the assessment of the lumbar spine and related structures such as paraspinal muscles and ligaments. Studies have been conducted that have suggested the role of fatty infiltration of the lumbar paraspinal muscles in predicting patient response to treatment for lower back pain [4].

There are many factors which make MRI the ideal and standard modality for the detection of disc related pathology including its lack of ionizing radiation and ability for multiplanar imaging. It also provides excellent spinal soft-tissue contrast and can precisely localize the pathological changes in intervertebral discs [6].

Although lower back pain is highly prevalent, many questions remain unanswered with respect to its pathophysiology. More work needs to be done to establish definite association between the imaging findings and patient's symptoms. Previously only limited information was available regarding the role of the paraspinal muscles in causing lower back pain. Recently increasing number of studies has been conducted attempting to highlight the possible association between the paraspinal muscle atrophy, lower back pain and spinal disc disease [7]. However no conclusive evidence is available in this respect till date and more work needs to be done to establish convincing relationship between paraspinal muscle atrophy and lumbar disc herniation. Our study aims to focus on the assessment of paraspinal muscles atrophy and possible relationship with lumbar disc herniation and spinal stenosis.

MATERIALS AND METHODS

We studied total 160 patients ranging in age between 21 to 65 years old from both genders between August 2019 and January 2020. Those were included who presented with history of lower back pain with or without associated symptoms of numbness and stiffness. Patients were referred from outpatient clinic by physician after clinical exam was done. Symptoms were noted and family history of spine disease was also interrogated. Systemic disease was also excluded on history and type and location of symptoms were recorded. Those patients were excluded who had incomplete MRI done due to some reason and those who had surgeries of spine. Patients with backache and having no disc herniation on MRI were also not included in study. Patients with congenital or developmental disease of musculoskeletal system and those with diagnosed spondylitis, spondylodiscitis and neoplasm (either primary or secondary) of the spine were also excluded.

The participants were subdivided on the basis of:

1-Education level

a- Low level below high school

b- Regular level until high school

c- High level college or university

2-Lifestyle

a- Passive

b- Regular

c- Active for example sportive.

Two ethnic groups were noted among the patients and they belonged to either Punjabi or Pathan.

We collected and analyzed the data on IBM SPSS version 23 and applied Chi square test to determine the significance of P value. Different variables were assessed for their frequency and their associations were determined. P value <0.05 was taken as statistically significant.

We studied MRI of total 160 patients according to the selection criteria described above. All patients were imaged on Toshiba 1.5 Tesla MRI in Radiology department of Sir Ganga Ram Hospital, Lahore. Same sequences of images were acquired in all patients including T1 weighted, T2 weighted and STIR images in sagittal plane with T1 weighted and T2 weighted images in axial planes at all lumbar levels. Paraspinal muscle atrophy was assessed by two radiologists in consensus to decrease the controversies in the study. Atrophy of paraspinal muscles including multifidus, longissimus and iliocostalis were assessed on T1 weighted as well as on T2 weighted axial images and correlation with disc herniation was noted. Muscle atrophy was graded with semi-quantitative method as per the criteria,

Grade 0: Normal (normal size, homogeneous signals without fatty infiltration)

Grade I: Size reduction (less than 50 % with fatty infiltration)

Grade II: Size reduction (over 50% with fatty infiltration)

Grade III: Complete fatty infiltration (complete absence of muscle fibers)

Disc herniation was taken as 2 mm beyond the vertebral margin. Patients with complex pattern of disc herniation showing more than one pattern were also not included to make the study and results more specific. Spinal stenosis was graded as mild, moderate and severe subjectively and some effacement of thecal sac was taken as mild, near total effacement of CSF in thecal sac was taken as moderate and total effacement was taken as severe (Figures 1-4).

RESULTS

Prospectively we studied MRI of 160 consecutive patients who had disc herniation on MRI, ranging in age between 21 to 65. Out of them 107 were males and 53 were females. We noticed that most common pattern of disc herniation was circumferential and was seen in 127 patients followed by central disc protrusion and then by paracentral herniation. Most common level of disc herniation was L4-L5 followed by L5-S1 and then L3-L4.

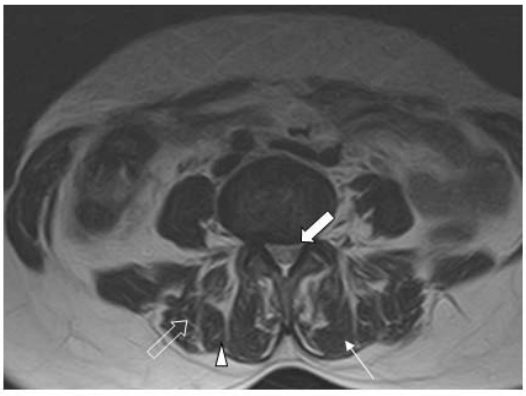

Figure 1 T2W axial image at L3-4 level showing diffuse disc bulge (thick arrow) with multifidus atrophy (thin arrow), longissimus atrophy (arrow head) and iliocostalis atrophy (open arrow). Paraspinal muscle atrophy is bilaterally symmetrical.

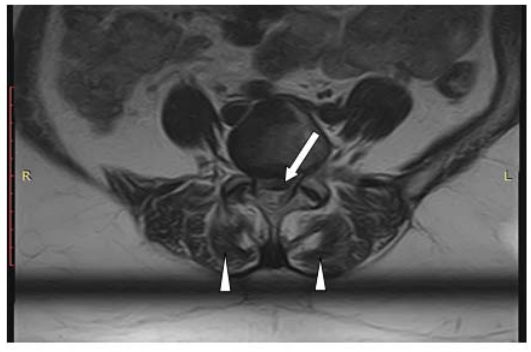

Figure 2 T2W axial image at L4-5 level showing central disc herniation (thick arrow) with bilateral symmetrical multifidus atrophy (arrow heads) and mild atrophy of longissimus and iliocostalis muscles.

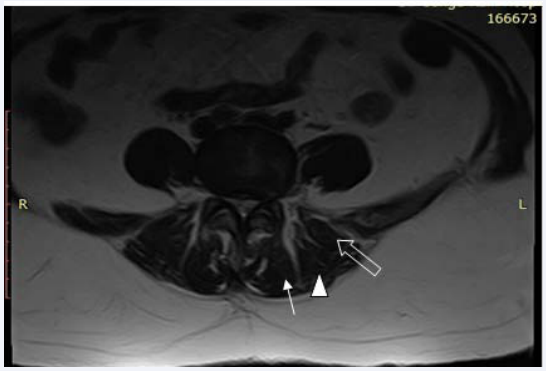

Figure 3 T2W axial image at L4-5 level showing moderate spinal canal stenosis with multifidus atrophy (thin arrow), longissimus atrophy (arrow head) and iliocostalis atrophy (open arrow). Paraspinal muscle atrophy is bilaterally symmetrical.

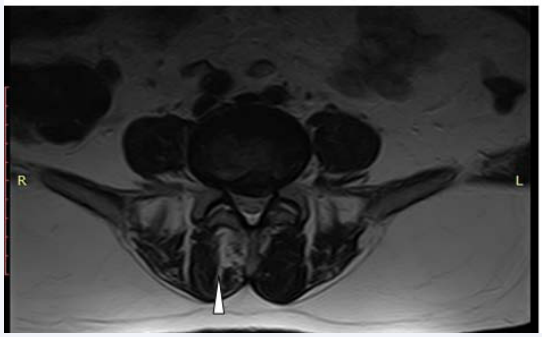

Figure 4 T2W axial image at L4-5 level showing diffuse disc bulge with asymmetrical multifidus atrophy more on right side (arrow head).There was right paracentral disc herniation at one level above but atrophy on right side was more prominent at this level.

Association between disc herniation and paraspinal muscles atrophy

Out of total 160 patients with disc herniation of any pattern 127 (79%) patients showed multifidus muscle atrophy. Majority of these patients had grade I and bilaterally symmetrical atrophy. 56% patients showed grade I and 32 % showed grade II and p value was insignificant (*P*= .15) (Table 1). Likewise in case of longissimus coli muscle atrophy was seen in 109(68%) patients (*P*= .588) and in iliocostalis was seen in 83 (52%) patients (*P*= .127) and most common pattern was grade I.

Multifidus muscle atrophy was seen bilaterally symmetrical in majority of patients (Table 2) who showed circumferential disc herniation while unilateral/predominant atrophy was observed in only 10 patients and all of them showed paracentral disc herniation either right or left (*P*< .001).

Longissimus atrophy was also bilateral in patients with circumferential disc herniation and only 5 patients had unilateral/dominant atrophy with paracentral disc herniation pattern (*P*<

Table 1: Type of disc herniation and multifidus muscle atrophy cross tabulation.

		Multifidus muscle atrophy				Total
		Grade 0	Grade 1	Grade 2	Grade 3	
Type of disc herniation	Circumferential	23	59	32	13	127
	Right	3	2	2	2	9
	Left	0	5	2	0	7
	Central	7	5	5	0	17
Total		33	71	41	15	160

Table 2: Type of disc herniation and multifidus muscle atrophy laterality/symmetry cross tabulation.

		Multifidus atrophy laterality			Total
		Unilateral/Dominant	Bilateral	none	
Type of disc herniation	Circumferential	0	104	23	127
	Right	5	1	3	9
	Left	5	2	0	7
	Central	0	10	7	17
Total		10	117	33	160

.001). Same pattern was observed in iliocostalis atrophy but with less number of patients and *P* value was significant too (*P<.001*).

Among three paraspinal muscles examined multifidus was affected most frequently followed by longissimus and then iliocostalis. The level of muscle atrophy correlated with the level of disc herniation on all three muscles and also inferiorly in many cases.

Association between spinal stenosis and paraspinal muscle atrophy

We noticed that out of total patients, 141 patients showed some degree of spinal stenosis. Out of 141 patients 127 (90%) patients had multifidus muscle atrophy. In patients with mild stenosis atrophy was seen in 66 patients (74%) and with moderate spinal stenosis in 93% and with severe stenosis 88% cases (*P<.001*) p value was significant. We noticed that atrophy was seen in association with all grades of spinal stenosis including mild, moderate and severe .Majority of cases showed grade I muscle atrophy followed by grade II and then grade III (Table 3). In case of longissimus same kind of trend was observed and muscle atrophy was seen in 77% of patients with spinal stenosis (*P*< .001). In case of iliocostalis 65 % of cases showed atrophy (*P*< .001).

We saw muscle atrophy more in ethnic group of punjabi than pathan and p value was not significant (*P*= .165).

It was observed that of all patients with disc herniation the majority of them had high school education level and p value was insignificant (*P*= .910).

Most of the patients with regular life style showed muscle atrophy. In patients with passive life style 93 % showed atrophy and with active life style 81 % and with regular life style 76% showed muscle atrophy (*P*=.008).

We also noticed that grade I and II muscle atrophy was more common in male patients however cases with grade III atrophy were mostly females. In multifidus muscle atrophy out of 15 patients with grade III atrophy 11 were females (*P*=.006) and same was true with longissimus.

DISCUSSION

In adults chronic lower back pain is reported as high as 20.3 percent and increases with life starting from the age of 30 years onwards. Decreased physical activity and sedentary lifestyle has been established as contributor to development of lower back pain and they in turn are related to weakness and atrophy of paraspinal muscles. Nerve root compression and disc herniation have effect on innervation of paraspinal muscles resulting in atrophy [8].

Several studies have assessed atrophy of paraspinal muscles in patients with low back pain in correlation with pain. Multifidus atrophy and fatty infiltration has been shown in unilateral lower back pain on the same side [9]. They found correlation between the side of lower back pain and ipsilateral atrophy of paraspinal muscles in patients with either acute or chronic back pain [9]. Association has also been seen between backache and decreased CSA and fatty infiltration of paraspinal muscles and also between disc herniation, radiculopathy with paraspinal muscle atrophy [10,11]. Review studies have noticed lack of adoption of uniform methods for paraspinal muscles evaluation in several studies which highlights the need for more studies to understand cause and effect relationship between changes in paraspinal muscles and spinal degenerative changes [12]. In one study it was concluded that multifidus muscle atrophy has role in cause of disc herniation / degeneration especially at L3- L4 level in one study. Muscle atrophy should be considered in treatment of lumbar disc herniation and lumber extension muscles strengthening program could be helpful in preventing muscle atrophy and spinal degeneration [3].

In other studies they noticed that paraspinal muscle atrophy was seen in patients not having lower back pain but due to aging however when they compared with patient having

neuromuscular diseases then they found atrophic changes were more severe and there was total fat replacement [13]. This shows that problems affecting the innervation of muscles can aggravate the atrophyin addition to other factors, which can even occur as age related phenomenon.Less improvement was seen in patients with more severe muscle atrophy or fatty infiltration after corrective surgery in one study [14].

But none of the above mentioned studies analyzed disc herniation pattern in correlation with laterality/dominance of paraspinal muscle atrophy. In our study we compared type of disc herniation with muscle atrophy grade and noticed that paraspinal muscle atrophy was quite frequent in patients with disc herniation independent of pattern. In our sample the majority of patients had circumferential disc herniation pattern but the atrophy was also noted in some patients with paracentral and central disc herniation and no specific pattern was responsible for atrophy. We could not find significant association between disc herniation pattern and muscle atrophy grade however we concluded that in majority of patients with degenerative disc herniation it has effect on paraspinal muscle volume which can alter the biomechanics of spine.

It was noticed in our study that majority of the patient had bilaterally symmetrical muscle atrophy at the level of disc herniation or inferior mostly with circumferential disc herniation pattern but unilateral/dominant atrophy was observed also in patients with paracentral disc herniation on the same side. We found significant relationship between side of disc herniation and side of muscle atrophy however limitation was limited number of patients with paracentral disc pattern because we included only consecutive patients with any type of disc disease. More studies need to be done to see the significance of side of disc herniation and muscle atrophy with greater sample.

Multifidus muscle was most commonly affected in atrophy followed by longissimus and then iliocostalis indicating that multifidus muscle is the most important muscle in the back giving strength and stability to the spine. No isolated atrophy of the erector spinae muscle was seen without multifidus atrophy.

Lumbar spinal stenosis is among the spectrum of degenerative spine changes and is common in older individuals. It has been proven in studies that paraspinal muscle denervation occurs in patients with spinal stenosis and posterior passing ramus is the main cause for this denervation rather than nerve root compression .In one prospective study they assessed correlation between paraspinal muscle atrophy and spinal stenosis. They compared asymptomatic subjects and subjects with mechanical low back pain with symptomatic spinal stenosis and they found that paraspinal muscle atrophy was more significantly in spinal stenosis group than low back painthan asymptomatic group. In this study the limitation was smaller sample size [15]. In one study they found poor correlation between degree of spinal stenosis and symptoms and functional impairment of the spine. They saw association between functional performance of patient with lumbar spinal stenosis and cross sectional area of multifidus and psoas major .In this study more decreased cross sectional area of muscles was seen in females than males and in our study we also noticed that severe atrophy patients were more females [16,8].

Significant association was seen in our study between muscle atrophy and spinal stenosis suggesting that spinal stenosis is a contributing factor in muscle atrophy resulting from compression on the nerve roots. In patients with severe stenosis almost all of them showed atrophy of muscles. Muscle atrophy was seen in all grades of spinal stenosis however more prevalence was seen in patients having severe spinal stenosis. We also noticed that even patient not having spinal stenosis also showed muscle atrophy suggesting that there are also other multiple causes contributing to paraspinal muscle atrophy. We did not correlate the duration of symptoms with muscle atrophy and this was the limitation.

CONCLUSION

Paraspinal muscle atrophy has significant prevalence in patients with degenerative disc herniation of any pattern and has significant association with spinal stenosis. More studies need to be done to determine the significance of correlation between side of disc herniation and unilateral or dominant atrophy of paraspinal muscle on same side so that therapeutic management can be directed towards specific exercises for unilateral muscle strengthening for these cases.

REFERENCES

1. Latif A, Zahara A, Cheema AS, Shabbir F, Butt MQ. Backache: Presentation and Diagnosis: A Prospective Study at Allama Iqbal Memorial Teaching Hospital Sialkot. PAKISTAN JOURNAL OF MEDICAL & HEALTH SCIENCES. 2018; 12: 89-93.
2. Gray H, Standring S. Gray's Anatomy-The Anatomical Basis of Clinical Practice (40th ed.) Churchill Livingstone- Elsevier. 2008: 684-689.
3. Sun D, Liu P, Cheng J, Ma Z, Liu J, Qin T. Correlation between intervertebral disc degeneration, paraspinal muscle atrophy, and lumbar facet joints degeneration in patients with lumbar disc herniation. BMC Musculoskelet Disord. 2017; 18: 167.
4. Berry DB, Padwal J, Johnson S, Parra CL, Ward SR, Shahidi B. Methodological considerations in region of interest definitions for paraspinal muscles in axial MRIs of the lumbar spine. BMC musculoskeletal disorders. 2018; 19: 135.
5. Haig AJ, Tong HC, Yamakawa KS, Quint DJ, Hoff JT, Chiodo A, et al. Spinal stenosis, back pain, or no symptoms at all? A masked study comparing radiologic and electrodiagnostic diagnoses to the clinical impression. Arch Phys Med Rehabil. 2006; 87: 897-903.
6. Suthar P, Patel R, Mehta C, Patel N. MRI evaluation of lumbar disc degenerative disease. Journal of clinical and diagnostic research: JCDR. 2015; 9: TC04 -TC09.
7. Kalichman L, Carmeli E, Been E. The association between imaging parameters of the paraspinal muscles, spinal degeneration, and low back pain. Biomed Res Int. 2017; 2017.
8. Faur C, Patrascu JM, Haragus H, Anglitoiu B. Correlation between multifidus fatty atrophy and lumbar disc degeneration in low back pain. BMC Musculoskelet Disord. 2019; 20: 1-6.
9. Wan Q, Lin C, Li X, Zeng W, Ma C. MRI assessment of paraspinal muscles in patients with acute and chronic unilateral low back pain. Br J Radiol. 2015; 88: 20140546.
10. He K, Head J, Mouchtouris N, Hines K, Shea P, Schmidt R, et al. The Implications of Paraspinal Muscle Atrophy in Low Back Pain, Thoracolumbar Pathology, and Clinical Outcomes After Spine Surgery: A Review of the Literature. Global Spine Journal. 2019; 9.
11. Cooley JR, Walker BF, Ardakani EM, Kjaer P, Jensen TS, Hebert

JJ. Relationships between paraspinal muscle morphology and neurocompressive conditions of the lumbar spine: a systematic review with meta-analysis. BMC musculoskeletal disorders. 2018; 19: 351.

12. Kalichman L, Carmeli E, Been E. The association between imaging parameters of the paraspinal muscles, spinal degeneration, and low back pain. Biomed Res Int. 2017; 2017.

13. Hadar H, Gadoth N, Heifetz M. Fatty replacement of lower paraspinal muscles: normal and neuromuscular disorders. AJR Am J Roentgenol. 1983; 141: 895-898.

14. Lee JH, Lee SH. Does lumbar paraspinal muscles improve after corrective fusion surgery in degenerative flat black?. Indian J Orthop. 2017; 51: 147.

15. Yarjanian JA, Fetzer A, Yamakawa KS, Tong HC, Smuck M, Haig A. Correlation of paraspinal atrophy and denervation in back pain and spinal stenosis relative to asymptomatic controls. PM&R. 2013; 5: 39-44.

16. Chen YY, Pao JL, Liaw CK, Hsu WL, Yang RS. Image changes of paraspinal muscles and clinical correlations in patients with unilateral lumbar spinal stenosis. Eur Spine J. 2014; 23: 999-1006.

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