Association of L-spine MRI facet joint degeneration phase difference between the firefighters and white-collar workers

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ABSTRACT

Objective: To find out if facet joint degeneration in firefighters, who are exposed to significant lumbar vertebra burden, differ from that in office workers. **Background:** : It is not unusual to see a Korean firefighter suffering from lower back pain. Male Korean firefighters often have to do difficult work that excessively burdens their lumbar vertebra, such as lift very heavy objects. This study was conducted to examine, through MRI, if this phenomenon is related to facet joint degeneration. **Method:** From L1 to S1, MRI tests were performed on the facet joints. The tests were conducted for the T1 and T2 weight images, and the level of facet joint degeneration was classified into 0, 1, 2, and 3, with 1, 2, and 3 indicating that the subject had degeneration. **Results:** The male firefighters showed greater likelihood of having FJD than the male office workers. In both the firefighter group and the office worker group, the FJD score tended to be higher in the older subjects. However, the slope of the FJD score was more significant in the firefighter group than in the office worker group. **Conclusion:** In the lumbar region, the radiographic degeneration of facet joints was studied and the differences between the results of the firefighter group and the office worker group were examined.

Keywords: facet joint, firefighters, low back pain, Journal of the Ergonomics Society of Korea

1. Introduction

Lower back pain (LBP) typically results in loss of working abilities, degradation of quality of life, and functional disabilities. Moreover, it has been reported that about 1% of the total world population has LBP, which is causing a lot of economic problems in the Western world. It is believed that LBP is also causing significant economic and social losses in other parts of the world. The causes of LBP among firefighters include physically demanding rescue operations, paramedic services, and firefighting, in which they are required to use heavy equipment. Handling and carrying patients, which firefighters do occasionally, also significantly burden their lumbar vertebra; and as a result, many of them report having LBP. Furthermore, in the aftermath of the Sewol incident, the poor working environment of firefighters is attracting increasingly greater attention in Korea. As a result, the lumbar vertebra disorders of Korean firefighters are being taken more seriously as a social problem. For this reason, this study compared, via magnetic resonance imaging (MRI) tests, the anatomical differences caused by work burdens on the lumbar vertebrae of the groups of firefighters and office workers, the latter of whom are often believed to be exposed to less burdens on their lower backs. MRI is used to examine LBP across the world. While many argue that LBP and abnormal lumbar vertebra findings on the MRI are closely related, many still believe they are unrelated. Especially, while there have been a number of studies on the relationship between subjective pain as the cause of LBP and disc degeneration in the MRI findings, the conclusion is still controversial [5-8]. However, there are reports that increased physical activities were related to higher prevalence of facet joint degeneration. Moreover, MRI has been found to be the best diagnostic tool for anatomical abnormalities in the lower back. Diagnostically, an anesthetic block on the facet joint may significantly mitigate LBP. For this reason, many studies have suggested that facet joint degeneration is related to LBP and physical activities. The body part currently most commonly treated for LBP in the United States is the facet joint. However, studies on the correlation between facet joint degeneration and LBP are scarce. It is even more difficult to find studies that compared subjects with physically demanding professions to a control group. Moreover, no study has examined the relationship between LBP and MRI findings in subjects with a specific profession, instead of comparing the patient groups and the control groups who visited the hospital. This study was conducted to examine and compare the changes in the degeneration of the facet joints of the firefighter group and the control group on the MRI and the subjective LBP, as well as the changes in the subjects' physical activities. Since the JESK one of the most active centrum of the Korean ergonomists' idea was launched, it has grown quantitatively as well as qualitatively in publication activities.

2. Method

Participants

This study was a firefighter-based study. It was a small-scale study derived from another study conducted to examine the relationship between the work activities of firefighters and their musculoskeletal diseases. Korean firefighters are harried by lack of manpower, frequent deployment, and excessive physical burdens. Especially, repetitive work and handling of heavy objects significantly burden the lower back. In this study, a group of office workers was selected as the control group because they were believed to suffer less from lower back burdens. For this reason, the subjects in the control group were selected from among hospital office workers instead of individuals who spend most of their time sitting, because such office workers are allowed to sit or stand as they please. The subjects were randomly sampled after stratification to ensure external validity. The territory of South Korea was divided into five provinces--Seoul, Gyounggi, Gyoungnam, Busan, Gwangju, and Jeonnam--from which the study subjects were selected. The subjects were stratified into three layers based on their gender (male and female), age group (20s, 30s, 40s, and 50s), and responsibilities (firefighting, paramedic services and rescue, and administrative work). Then they were randomly sampled from these three layers. With these subjects, a self-reported survey was conducted to find out if the subject had subjective LBP in the past year and if he or she did, to evaluate such LBP, in addition to conducting lumbar vertebra MRI tests. From the subject population, 422 male firefighters were selected for this study. For the control group, a total of 80 hospital office workers were included.

The sampling was performed in such a way as to make the demographic composition of the firefighter group similar to that of the control group.

Magnetic Resonance Imaging

For the MRI tests, 1.5 tesla MRI was used. The imaging test configurations were the sagittal T1 and T2 WI (both to include the neural foramen), the axial T1 and T2 (including the superior and inferior end plates, horizontal to the lumbar vertebra disc), the slice thickness (4 mm), the sagittal location view length (top-bottom, 146-150 mm), the imaging intensity consistency (T1/T2 = 87.5% or higher), the ghost signal percentage (T1 = 2.5 or lower), and the contrast resolution (T1/T2). To enhance the reliability of the MRI readings, four imaging test specialists with subspecialties in musculoskeletal diseases evaluated the images. The specialists were blinded to the subject information, and both were asked to evaluate each subject. As for the match ratio for the degenerative changes in the facet joints, the gamma value between Evaluator 1 and Evaluator 2 ranged from 0.458 to 0.77, and the gamma value between Evaluator 3 and Evaluator 4 was 0.7 or higher.

Facet Joint Degeneration Grading

To evaluate the facet joint degeneration, the images were divided into the left and right sections, and then L12, L23, L34, L45, and L5S1 were evaluated. The results were graded at a scale of 0 to 3, with 0 denoting a degeneration-free state, and 3, the highest level of degeneration [11]. Then the results were classified as showing "No facet joint degeneration" if the grade was 0, or as "with facet joint degeneration" if the grade was 1, 2, or 3. The facet joint degeneration score (FJDS) was the sum of the grades, that is, 0, 1, 2, or 3, for the left and right facet joint degeneration.

Statistical Analyses

First, a frequency analysis was conducted to understand the general characteristics of the subjects. The demographic analysis included variables such as the prevalence of LBP, age group (20s, 30s, 40s, and 50s) percentages, profession (firefighter or not), job type, marital status, education level, household income level, total years in service, drinking habits, smoking habits, workout frequency, service type, height, and body weight. Second, a chi-square independence test was conducted with the classified data to analyze the history of LBP, marital status, education level, household income level, years in service, drinking habit, smoking habit, workout frequency, and service type. Third, the individual's profession (firefighting or not) was considered a dependent variable. Then if the sum of the grades of the left and right facet joint degeneration at each level was 0, the level was considered with facet joint degeneration; and if the score was 1 or higher, the level was considered with face joint degeneration. As such, the existence of facet joint degeneration was considered an independent variable, which was put to a binary logistic regression analysis comparison to calculate the odds ratio. All the empirical analyses in this study were verified at a significance level of $p < 0.05$, and the statistics were processed using R software.

Table 1. Demographic characteristics of the study participants

Profession	Office worker	80	19.0%
	Firefighter	342	81.0%
History of back pain	No	145	34.4%
	Yes	277	65.6%
Job type	Control	80	19.0%
	Firefighting	101	23.9%
	Paramedic services	111	26.3%
	Rescue	47	11.1%
	Administration and others	83	19.7%
Age	20-29	109	25.8%
	30-39	117	27.7%
	40-49	106	25.1%
	50-59	90	21.3%
Marital status	Unmarried	127	30.1%
	Married	281	66.6%
	Refused to answer	14	3.3%
Education level	High school or lower	83	19.7%
	2-year college	97	23.0%
	4-year college	199	47.3%
	Refused to answer	42	10.0%
Household income level	KRW 3 million or less	168	44.8%
	KRW 3-5 million	160	42.7%
	KRW 5 million or higher	47	12.5%
Years in service	Less than 5 years	128	32.7%
	5-10 years	61	15.6%
	10-15 years	34	8.7%
	15-20 years	54	13.8%
	20 years or more	115	29.3%
Drinking habit	Non-drinker	93	24.2%
	Drinker	292	75.8%
Smoking habit	Non-smoker	136	35.2%
	History of smoking	129	33.4%
	Currently smoking	121	31.3%
Workout frequency	Not at all	36	10.0%
	Once a week	88	24.4%
	Twice or more in a week	236	65.6%
Work shift	Daytime shift	160	41.9%
	24 hours, 2 shifts	65	17.0%
	Shifting duties	157	41.1%
Current LBP	No	234	60.5%
	Yes	153	39.5%
Height		174.4±16.42 cm	
Weight		73.4±8.36 kg	

3. Results

With regard to the education level, the subjects with a four-year college diploma were 98% more likely to be firefighters (1 - 0.020 = 0.980) than those with a less than four-year college education. The subjects with less than a four-year college education were also more likely to be firefighters than those with a four-year college education.

As for the household income, the subjects who earned KRW 3-5 million won were 28.7% (1 - 0.713 = 0.287) more likely to be firefighters than those who earned less than 3 million won. The subjects who earned less than KRW 3 million were also more likely to be firefighters than those who earned KRW 3-5 million won. The subjects who earned at least 5 million won were 89% (1 - 0.110 = 0.890) less likely to be firefighters than those who earned less than 3 million won. The subjects who earned less than 3 million won were more likely to be firefighters than those who earned at least 5 million won. In the case of the FJ_L45 degeneration, the P value was 0.05 or higher. However, compared to the office workers, the odds ratio of the firefighter group was 2.281, and the P value of their FJ_L51 degeneration was 0.053 and its odds ratio, 2.904, which signified that the firefighters tended to suffer more significant degeneration at the L4 and L5 levels and at the L5 and S1 levels of their lumbar vertebrae than the office workers.

At the FJ_L12, Abnormal was 1.736 times more likely to be a firefighter than Normal. Thus, Normal was less likely to be a firefighter. At the FJ_L23, Abnormal was 1.393 times more likely to be a firefighter than Normal. Thus, Normal was less likely to be a firefighter. At the FJ_L34, Abnormal was 1% less likely to be a firefighter than Normal (1 - 0.690 = 0.310). Thus, Normal was more likely to be a firefighter. At the FJ_L5S1, Abnormal was 1.349 times more likely to be a firefighter than Normal. Thus, Normal was less likely to be a firefighter.

Table 2. Examination of the influential factors based on the profession

Variable	Beta	SE	P	Exp(B)	95% CI for EXP(B)	
					LB	UB
History of back pain	-0.186	0.579	0.749	0.830	0.267	2.585
Age			0.110			
20-29 vs. 30-39	0.046	0.697	0.947	1.047	0.267	4.102
20-29 vs. 40-49	0.074	0.832	0.929	1.077	0.211	5.503
20-29 vs. 50-59	-1.625	0.939	0.083	0.197	0.031	1.240
Marital status	1.026	0.615	0.095	2.791	0.837	9.309
Education level	**-3.908**	**0.731**	**0.000****	**0.020**	**0.005**	**0.084**
Household income level			**0.013***			
300(-) vs. 300-500	-0.339	0.581	0.560	0.713	0.228	2.225
300(-) vs. 500(+)	**-2.210**	**0.793**	**0.005****	**0.110**	**0.023**	**0.519**
Drinking habit	-0.852	0.611	0.163	0.426	0.129	1.411
Smoking habit			0.267			
Non-smoker vs. History of smoking	0.152	0.545	0.780	1.164	0.400	3.388
Non-smoker vs. Currently smoking	0.914	0.577	0.113	2.494	0.805	7.727
Workout frequency			0.402			
None vs. Once a week	-1.487	1.205	0.217	0.226	0.021	2.400

Variable	Beta	SE	*P*	Exp(B)	95% CI for EXP(B)	
					LB	UB
None vs. Two or more times a week	-0.975	1.126	0.387	0.377	0.042	3.427
Current LBP	0.712	0.580	0.220	2.038	0.654	6.356
Height	0.068	0.050	0.177	1.070	0.970	1.181
Weight	0.016	0.032	0.618	1.016	0.954	1.082
FJ_L12 degeneration	0.720	0.576	0.212	2.054	0.664	6.356
FJ_L23 degeneration	-0.511	0.635	0.421	0.600	0.173	2.083
FJ_L34 degeneration	-0.397	0.601	0.508	0.672	0.207	2.181
FJ_L45 degeneration	0.825	0.608	0.175	2.281	0.693	7.507
FJ_L5S1 degeneration	**1.066**	**0.550**	**0.053**	**2.904**	**0.988**	**8.536**

*P < 0.05, **P < 0.01

Table 3. Influence of normal or abnormal face joint degeneration on the profession

Variable	Beta	SE	*P*	Exp(B)	95% CI for EXP(B)	
					LB	UB
FJ_L12	**0.552**	**0.182**	**0.002****	**1.736**	**1.217**	**2.478**
FJ_L23	**0.331**	**0.167**	**0.047***	**1.393**	**1.004**	**1.932**
FJ_L34	**-0.372**	**0.164**	**0.023***	**0.690**	**0.500**	**0.951**
FJ_L45	0.026	0.166	0.878	1.026	0.740	1.422
FJ_L5S1	**0.299**	**0.144**	**0.038***	**1.349**	**1.017**	**1.788**

-2log likelihood = 1571.539, Cox & Snell = 0.320, adj. Nagelkerke = 0.332 R^2 R^2

*P < 0.05, **P < 0.01

4. Conclusion

This study made it possible to understand the prevalence of LBP in a specific occupation group. As the height and the weight of the group were similar to those of the general adult male population of Korea, this study was obviously well-randomized and selected the participants soundly. In the logistic regression analysis to examine the influential factors based on the occupation, the P value was 0.053, which was close to the significant level. Therefore, the odds ratio at the FJ_L5S1 was 2.904. At the FJ_L4L5, the P value was 0.175, which is insignificant, and the odds ratio was 2.281. With the occupation as the dependent variable, and with the FJ_L12, FJ_L23, FJ_L34, FJ_45, and L5S1 as the other variables, the firefighter group showed a much higher degeneration tendency at the FJ_L12, FJ_L23, and FJ_L5S1. Especially, the degeneration at the L5S1 tended to be stronger in the firefighter group. There have been reports that there is no correlation between degeneration of the disks and LBP. However, the causes of LBP are not governed by the structure of a single lumbar vertebra.

Acknowledgements

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