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ORIGINAL ARTICLE

Radiographic changes in the lumbar spine in former professional football players: a comparative and matched controlled study

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Abstract Heavy physical work and activity lead to degenerative changes, especially in the lumbar spine. We aimed to find out the occurence of radiographic changes (vertebral osteophytes, heights of lumbar dicsc, concavity index) and abnormalities of the lumbar spine in former professional football (association football or soccer) players according to their specialization (goalkeeper, defender, midfielder, forward) in their past professional sport life.

We included 70 male former professional football players and 59 men as the control group. The football players group consisted of 15 defenders (21%), 29 midfielders (41%), 18 forwards (26%) and 8 goalkeepers (12%). Their mean professional football life was 11.04 years and the mean time period after their retirement was 13.87 years. Radiographs of both groups were taken to measure the disc height, concavity index and to determine osteophytes and abnormalities of the lumbar spine. FFbH-R score was assessed for daily activities.

The mean FFbH-R score of football players was lower than that of the control group ($P = 0.005$). The total number of osteophytes in the player group was higher than in the control group ($P = 0.001$). The mean disc height of L1–L2 in football players was higher than in the control group ($P = 0.045$). The mean disc height of T12–L1 in goalkeepers was higher than in forward players ($P = 0.019$). The mean concavity index of L1 in forward players was lower than in defenders ($P = 0.018$). The mean disc heights of T12–L1 and L2–L3 were both higher in players whose professional sport life was >10 years than in players with ≤10 years ($P = 0.018$, $P = 0.016$). The mean disc height of L5–S1 was higher in players who had continued sport activity after retirement ($P = 0.025$). No statistically significant result was obtained with the rest of the variables.

Playing football is heavy work. The decreased height of lumbar discs and the lower value of concavity index of forward players are because the lumbar spine of forward players is loaded more than in the rest of the players.

Keywords Football players · Lumbar spine · Osteophyte · Concavity · Anterior disc height

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Introduction

Heavy physical work and activity lead to degenerative changes in the spine [7–9, 16, 18, 19, 21, 24]. Studies on different athletic disciplines and heavy workers have given variable degenerative changes and abnormalities in the lumbar spine [2, 3, 6–8, 12, 14, 18, 19, 21]. The football game, also known as "association football" or "soccer", is one of the most popular and spectacular sports all over the world and is associated with a high incidence of trauma

[6, 8, 14]. The effortful activity level of these players and their struggle to win not only exposes them to tremendous loads on their spinal column during practise and in competitions, but also often requires them to bear even more intense single-event loads during off-season training [6, 8]. Several researchers have conducted studies to find out whether there was any relation between active sport life and spondylolitic and degenerative changes with low back pain in football players [1, 4, 6, 8]. However, to our knowledge, none of those studies has dealt with the degenerative changes of the lumbar spine in former professional football players with respect to their player specializations.

This study focuses on radiographic changes (vertebral osteophytes, heights of lumbar dicsc, concavity index) and abnormalities (spondylolisthesis, decrease in lumbar lordosis) in the lumbar spine of former professional football players with regard to the specializations of the players (goalkeeper, defender, midfielder, forward) in their active sport life. It compares them with a matched control group, as well.

Materials and methods

The football players were recruited from an association, the members of which were retired professional football players in our city. The members were informed about the study and asked whether they wanted to participate. There were 75 members and 3 of them did not want to take part in the study. Two smokers were excluded and the rest (70) wanted to be included in the study and signed an informed consent. The mean age, height, weight and body mass index (BMI) of the former football players were 45.64 ± 8.39 years (range 29–72), 176.27 ± 5.29 cm, 81.35 ± 10.88 kg and 26.21 ± 3.75, respectively. The control group was selected among male patients admitted to outpatient clinics other than Orthopaedics and Traumatology, Neurosurgery and Physical Medicine and Rehabilitation in a week's interval. They were interviewed and informed about the study. A total of 59 men who wanted to participate in the study and met the below-mentioned inclusion criteria signed an informed consent and constituted the control group. The inclusion criteria for the study were as follows:

(1) age between 30 and 75 years and BMI between 20 and 32
(2) nonsmokers
(3) without any history of chronic disorder
(4) without any history of back-related surgery
(5) without any history of musculoskeletal disorder and surgery related to the locomotor system.

Table 1 Demographic data of two groups

	Football players (n = 70)	Control (n = 59)	P
Age	45.64 ± 8.39	45.69 ± 9.38	NS
Height (cm)	178.56 ± 4.96	173.41 ± 4.22	NS
Weight (kg)	81.93 ± 8.15	80.63 ± 13.59	NS
BMI	25.68 ± 2.21	26.87 ± 5.01	NS

n number, *BMI* body mass index, *NS* not significant

The demographic data of both groups were identical to each other (Table 1). The distribution of player specializations was as follows:

(1) defender, 15 (21%)
(2) midfielder, 29 (41%)
(3) forward, 18 (26%)
(4) goalkeeper, 8 (12%).

Their mean professional football life was 11.04 ± 3.66 years and the mean time period since their retirement was 13.87 ± 8.39 years.

Age, BMI and current physical activity at the time of evaluation were documented. Details of medication intake during active sport life were also requested from subjects.

Plain anteroposterior and lateral lumbosacral radiographs were made to measure the heights of lumbar dicsc and concavity index, and to determine spondylolysis, spondylolisthesis, the occurence of osteophytes and abnormalities of the lumbar spine. To find out whether there was an effect of the length of professional football life on the degeneration of the lumbar spine, players with an active sport life of more than and less than 10 years were also compared.

The radiograph beam was focused on L3 with an anode-film distance between 1.0 and 1.2 m. The height of the lumbar discs was measured according to the Leivseth protocol [11], and the concavity index for each vertebra was calculated, dividing the "central" vertebral height by the anterior vertebral height [23]. The presence of anterior osteophytes on the lumbar vertebra was determined by using a score (none or definite) for each of the six levels.

All radiographs were independently assessed by three raters in a blind fashion. If there were three different values, the median value was used.

To assess how far the subjects were restricted in their activity of daily living (ADL), an analysis was conducted with the Hannover Functional Ability Questionnaire for measuring back pain-related disability (FFbH-R) [10]. The FFbH-R is a short, self-administered questionnaire for the assessment of functional limitations in ADLs in patients with musculoskeletal disorders (subjects can choose between "yes", "yes, but with trouble", "no or with the

help of another person" to answer 12 questions, such as "Can you wash your hair in the washbasin?"). Data from different studies indicate that the FFbH-R meets the relevant psychometric criteria of acceptability, reliability, validity and sensitivity to change [10].

Statistical analysis

Statistical analysis was performed using SPSS 10.0 version for windows program (SPSS Inc., Chicago, IL, USA). FFbH-R scores, disc heights and concavity indexes were presented on the basis of average (± standard deviation). Prevalance of osteophytes and FFbH-R questionnaire were presented as frequency (%). Since the distribution of the study parameters showed normal distribution, parametric statistics were used. Therefore, *t*-test and one-way ANOVA tests were used for the comparison of the distributions of values between groups and the values of player specializations. Pairwise comparisons were performed with Bonferroni test. Categorical variables were compared with Pearson chi-square test. Statistical significance was assigned to P values less than 0.05.

Results

Findings of football players and control subjects

The mean FFbH-R score for football players and control group were found to be 97.38 ± 7.02 and 99.85 ± 1.11, respectively (95% confidence interval of the difference = 0.8–4.5; $P = 0.005$). In FFbH-R, the answers to the questions "Can you sit on a chair in only one position?" and "Can you stand for about 30 min without a break in a queue?" differed statistically between the two groups ($P < 0.05$). In football players, the absolute heights of lumbar discs increased from level T12–L1 to a maximum at L4–L5 and decreased slightly again from level L4–L5 to L5–S1. In the control group, the absolute heights increased linearly from T12–L1 to a maximum at L5–S1. The disc heights of the lumbar spine in the football player group were higher than in the control group at the level L1–L2 ($P = 0.045$). No significant difference was found in the rest of lumbar discs. Concavity indexes for all lumbar vertebrae for the two groups did not differ statistically (Table 2).

A significantly higher rate/prevalance of osteophytes was found at levels T12, L1, L2 and L4 in football players than in control group in our radiographic examination of lumbar spines according to the criteria for radiographic changes ($P \leq 0.01$). No significant difference was found at levels L3 and L5 (Table 3).

Table 2 Comparison of variables between two groups

	Football players ($n = 70$)	Control ($n = 59$)	P
TOTFFbH-R	23.37 ± 1.68	23.96 ± 0.26	0.005
FFbH-R%	97.38 ± 7.02	99.85 ± 1.11	0.005
T12-L1 dh	11.10 ± 2.12	10.75 ± 2.48	NS
L1-L2 dh	13.96 ± 2.03	13.21 ± 2.12	0.045
L2-L3 dh	16.06 ± 2.16	15.68 ± 2.70	NS
L3-L4 dh	17.22 ± 2.40	17.21 ± 2.36	NS
L4-L5 dh	19.40 ± 3.02	19.32 ± 3.32	NS
L5-S1 dh	19.25 ± 3.64	19.95 ± 4.04	NS

n number, *TOTFFbH-R* total FFbH-R score, *T* thoracic, *S* sacral, *FFbH-R%* score in hundred of FFbH-R, *L* lumbar, *NS* not significant, *dh* disc height

Findings in football players according to player specializations

FFbH-R scores did not yield significant difference between football players according to player specializations.

Although rate/prevalence of osteophytes yielded no significant difference between football players according to player specializations, it gave the highest scores in goalkeepers and the forward players were the second. The rate/prevalence of osteophytes was found to be similar in defenders and midfielders.

The mean disc heights of lumbar discs of goalkeepers at all levels from T12–L1 to L5–S1 were found to be higher than in the rest of the players at different positions, although significant difference was found between goalkeepers (13.42 ± 3.15) and forward players (10.28 ± 2.04) only at the T12–L1 ($P = 0.011$).

The concavity index of the lumbar vertebrae of forward players showed the least values at all levels from T12 to L5. But, only significant difference was found at the L1 level between forward (0.65 ± 0.01) players and defenders (0.76 ± 0.08; $P = 0.018$). No significant difference could be found in the concavity indexes for all lumbar vertebrae among different player positions (Table 4).

The mean lumbar disc heights in players whose professional football life was less than 10 years were found

Table 3 Occurence of osteophytosis in two groups

Level	Football players ($n = 70$)	Control ($n = 59$)	P
T12	19 (27.1%)	3 (5.4%)	0.001
L1	19 (27.1%)	3 (5.49%)	0.001
L2	17 (24.3%)	4 (7.1%)	0.01
L3	20 (29%)	11 (19.6%)	NS
L4	36 (51.4%)	16 (28.6%)	0.01
L5	24 (34.3%)	11 (19.6%)	NS

n number, *T* thoracic, *L* lumbar, *NS* not significant

Table 4 Height of discs and concavity index of lumbar vertebrae according to player positions

	Defender	Midfield	Forward	Goalkeeper	*P*
T12-L1 dh	11.21 ± 1.38	11.02 ± 1.95	10.28 ± 2.04	13.42 ± 3.15	0,019
L1-L2 dh	13.77 ± 2.24	13.55 ± 1.97	14.00 ± 1.90	15.69 ± 1.44	NS
L2-L3 dh	16.33 ± 2.49	15.84 ± 1.97	15.77 ± 2.43	17.00 ± 1.48	NS
L3-L4 dh	16.43 ± 2.78	17.17 ± 2.50	17.31 ± 2.09	18.69 ± 1.44	NS
L4-L5 dh	20.07 ± 3.20	19.26 ± 2.90	18.83 ± 2.67	19.94 ± 4.02	NS
L5-S1 dh	18.93 ± 3.75	19.21 ± 3.39	20.69 ± 3.67	16.75 ± 3.31	NS
T12 ci	0.71 ± 0.05	0.71 ± 0.079	0.70 ± 0.05	0.70 ± 0.016	NS
L1 ci	0.76 ± 0.08	0.73 ± 0.06	0.65 ± 0.01	0.73 ± 0.03	0,018
L2 ci	0.79 ± 0.07	0.74 ± 0.09	0.74 ± 0.07	0.76 ± 0.08	NS
L3 ci	0.84 ± 0.05	0.84 ± 0.08	0.82 ± 0.08	0.85 ± 0.04	NS
L4 ci	0.84 ± 0.07	0.86 ± 0.06	0.81 ± 0.07	0.86 ± 0.08	NS
L5 ci	0.77 ± 0.07	0.77 ± 0.07	0.72 ± 0.07	0.76 ± 0.07	NS

T thoracic, *L* lumbar, *S* sacral, *NS* not significant, *dh* disc height, *ci* concavity index

less at all levels from T12–L1 to L5–S1, although significant difference was detected at T12–L1 and L2–L3 ($P = 0.018$, $P = 0.016$).

The football players were divided into two groups, as players continuing/not continuing sports activities after their retirement, to assess the effect of practising on the lumbar vertebrae. No significant difference was found between the two groups with regard to all of the variables, except in the L5–S1 disc height, which was higher in players who had continued sports activity after retirement ($P = 0.029$; 20.2 ± 3.7 and 18.3 ± 3.4 respectively).

We detected Grade 1 L5–S1 spondylolisthesis in two players, one midfielder and one goalkeeper. Grade 1 L4–L5 spondylolisthesis was detected in four players, one forward player, one goalkeeper and two midfielders. Grade 1 L3–L4 spondylolisthesis was detected in two players, one goalkeeper and one defender. In the control group, Grade 1 L5–S1 spondylolisthesis in two cases and Grade 1 L4–L5 spondylolisthesis in one case were detected. Decrease in lumbar lordosis was seen in six players, three midfielders, two defenders and one goalkeeper, although they were above the lowermost physiologic value. No statistical difference was found among different player specializations and between the football players and the control group ($P > 0.05$).

Discussion

The relation between lumbar spine abnormalities and ADL has been debatable [3, 12, 19]. Lundin et al. [12], in their investigation on 134 former top athletes of different sports, including wrestling, gymnastics, soccer and tennis, found no correlation between back pain and any specific radiologic abnormality or in the number of different radiologic abnormalities. But, they determined a significant correlation between back pain and a decrease in disc height during the 13-year follow-up period. Schmitt et al. [19], in their study reviewing lumbar spines of retired javelin throwers, found that athletes with and without radiologically demonstrated spondylolisthesis complained of no more back problems than the normal population. Tsai and Wredmark [22], in their study comparing former elite gymnasts with an age-matched control group, found no difference in back problems between gymnasts and the control group. Contrary to those, Granhed and Morelli [3] also evaluated low back pain among retired wrestlers and heavy lifters and concluded that the lifetime incidence and prevalence of low back pain had been higher among wrestlers compared with both the lifters and the control group. But, they added that this could not interfere with their work and they proposed that wrestlers during their active time had gained a higher tolerance for pain. In our study, we found that the FFbH-R scores were lower in football players. We agree with Granhed and Morelli [3]. Although football players in our study showed less value of FFbH-R scores, they were able to perform all the activities of daily life. The difference in the FFbH-R score arose from only two questions and any difference in FFbH-R score does not always mean a limitation in daily activities. Regarding the player positions, we found no difference. Similarly, Schmitt et al. [18], in their study in which they evaluated radiographic changes in the lumbar spine of former elite athletes, found no difference among different athletic disciplines in the FFbH-R assessment.

Varying rate/prevalence of osteophytosis has been reported in players associated with various disciplines of sports [6–8, 15, 18, 19]. In the present study with 70 football players, we found no significant difference among player specializations with regard to the rate/prevalence of

osteophytosis. But, a slightly higher rate/prevalence of osteophytosis was seen in goalkeepers and forward players (Table 5). Vertebral osteophytosis is related to manual labor and patterns of heavy loading [6, 7, 15, 16, 18, 19, 24]. Riihimäki et al. [16] concluded that heavy physical work did not alter, but merely enhanced the degenerative process of the lumbar spine. Anterior osteophytes are spurs of bone where ligaments are inserted and are a reflection of the physiology of life. Heavy physical loading, with the effect of repetitive hyperextension and rotation, seems to lead to the occurence of traction spurs. On the field, goalkeepers try to stop shots leadin to goals by leaving the ground, falling down or jumping. Additionally, they mostly send the ball away to begin an attack. So, the goalkeepers naturally do hyperextension and rotational movements more frequently than other field players in the game of football. Several studies suggest a positive correlation between osteophytosis and heavy occupational or sportive activity [6, 8, 15, 18, 19, 24]. On comparing the football players and the control group, we found more osteophytosis at T12, L1, L2 and L4 in football players. This is in accordance with literature that mechanical loading due to heavy work and excess activity causes the formation of osteophytes especially in the lumbar spine. O'neill et al. [15], in their population based survey, noticed that the excess risk of reported heavy activity between age 25 and 50 years in men pointed to occupational activity as being an important factor. Traction spurs might have been reported to indicate segmental instability [13, 17] Macnab [13] stated that the traction spur appeared to be primarily the result of abnormal motion, and it might or might not cause symptoms. Supporting that conclusion, Schaller [17] studied 12 patients who had signs of symptomatic segmental single-level instability after lumbar microdiscectomy and found traction spurs in only 4 of them. In our study, there was no one with sudden back pain associated with traction spurs.

Several parameters have been claimed to increase or decrease the height of lumbar discs [18, 20]. Greater signs of disc degeneration of the lumbar spine could be demonstrated in weight lifters and in the lower lumbar spine in soccer players as compared with runners and shooters [3, 18]. Schmitt et al. [19] stated that particularly javelin throwers showed increased lumbar disc heights as compared with runners and added that the low disc height seen at the lowest level of the lumbar spine compared with the upper levels showed the important role of this level in athletes from all throwing disciplines and those competing in high jump. Although in our study we found increased disc heights of lumbar vertebrae for all levels except L5-S1 in goalkeepers, it yielded significant difference at the T12–L1 disc height, which was lower in forward players. Holm and Nachemson [5] showed experimentally the positive effect of motion in the nutrition of intervertebral discs. Similar to Schmitt et al. [19], we also think that exercises including jumping and throwing with strengthening training and sudden impulse pattern of mechanical loading may have positive nutritional effects on the disc by enhancing the transport of small solutes in and out of the disc. Goalkeepers, who are similar to throwing athletes, do throwing and jumping movements to stop shots. Marathon runners have been shown to have less disc heights [18]. Similar to runners, forward players make running periods during the football game. Schmitt et al. [18] proposed a hypothesis that frequent high compression loading of the spinal column of marathon runners led to a height reduction in intervertebral discs and therefore competitive running could have a negative effect on the nutrition of the discs. But, this hypothesis could not be explained by their study. We agree with Schmitt et al. [18] in that disc height seems to be influenced by genetic or other unknown factors, but less by mechanical forces or models. The other field players do fewer jumping movements than the goalkeepers and they are not allowed to use their hands during the game. We think that the reason why goalkeepers have more disc heights at all levels except L5–S1 may be explained by their repetitive movements of throwing and jumping. One of the reasons why there was no striking differences among the different player positions may be because of the similar movement patterns of football players during the game and especially during practise periods.

Moorman et al. [14], in their study on elite lineman in American football, concluded that the hyperconcavity of the vertebral endplates was an adaptive change occuring over time in response to repetitive high loading and axial stress. It is clear that decreased concavity index of forward players at L1 in our study may be a result of repetitive increased loadings of forward players.

In the present study, active football life less than 10 years resulted in the decrease of lumbar disc heights. But the concavity index and occurence/rate of osteophytosis yielded no difference with regard to the active length

Table 5 Occurence of osteophytosis according to vertebrae

Level	Defender (n = 15)	Midfield (n = 29)	Forward (n = 18)	Goalkeeper (n = 8)
T12	3 (20%)	6 (20.7%)	6 (33.3%)	4 (50.4%)
L1	3 (20%)	8 (27.6%)	5 (27.8%)	3 (37.5%)
L2	3 (20%)	5 (17.2%)	5 (27.8%)	4 (50%)
L3	2(14.3%)	6 (20.7%)	8 (44.4%)	4 (50%)
L4	5 (33.3%)	13 (44.8%)	12 (66.7%)	6 (75%)
L5	3 (20%)	11 (37.9%)	6 (33.3%)	4 (50%)

n number, *T* thoracic, *L* lumbar, *NS* not significant

of football life. Additionally, L5–S1 disc heights were higher in players who have continued sports activity after retirement. So, we think that a long active football life has positive effects on the height of lumbar discs.

As a conclusion, playing football is an effortful work. The lumbar spine of forward players is exposed to higher loads than the other players with other specializations in association football, resulting in the decreased height of lumbar discs and lower values of concavity indexes.

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