Radiological Evaluation of the Line Between the Crista Iliaca (Tuffier's line) in Elderly Patients

Burcu Özalp Horsanalı¹, Zeki Tuncel Tekgöl¹, Murat Yaşar Özkalkanlı¹, Zehra Hilal Adıbelli², Özgür Esen², Fulya Yılmaz Duran¹

¹*Clinic of Anaesthesiology and Reanimation, İzmir Bozyaka Training and Research Hospital, İzmir, Turkey*

²*Clinic of Radiology, İzmir Bozyaka Training and Research Hospital, İzmir, Turkey*

Objective: Tuffier's line is defined as the line connecting the highest points of both iliac crests, which generally passes through either the body of the fourth lumbar vertebra or the intervertebral space between fourth and fifth vertebrae. In this study, we assessed the radiological correlation of the level of Tuffier's line with changes in age and sex.

Methods: In this study, antero-posterior pelvic X-rays of 590 patients aged 18 and older were retrospectively analyzed. It is revealed that Tuffier's line crosses the vertebral column at one of three levels, which are the L4 vertebral body, L4-L5 vertebral interspace and L5 vertebral body. Patients' sex, age and vertebral level of the Tuffier's line were recorded. Data was analyzed using the chi-square test.

Results: The assessment of the X-rays of 317 female patients showed that Tuffier's Line passes through the L4 vertebral body in 115 (37.8%), through the L4-L5 intervertebral space in 126 (40%) and through the L5 vertebral body in 76 (22.2%) patients. A Tuffier's line passing through the level of the L5 vertebral body was found to be statistically significant in female patients ($p=0.00$). No significant relevance was found between male gender and the level of Tuffier's line in 273 male patients. It is found that the height of the vertebral levels that Tuffier's line crosses does not correlate with mean age of the groups ($p=0.939$).

Conclusion: It should be considered that Tuffier's line can cross at vertebral levels other than anticipated. The level of Tuffier's line should be precisely determined with supplementary radiological methods, such as AP pelvic X-ray in addition to physical examination, to reduce the complications in association with regional anaesthesia and to achieve sensorial block levels sufficient to sustain a comfortable surgery, particularly in female patients who carry higher cardiac and respiratory risks.

Keywords: Tuffier's line, crista iliac, age, sex

Introduction

Tuffier's line is the line joining the highest points of both iliac cristae and generally passing across the fourth lumbar (L4) vertebral body or between the fourth and fifth lumbar vertebrae (L4-L5) (1). In routine clinical practice, the intervertebral space through which the Tuffier's line passes is determined in patients who will undergo the neuraxial block, and the procedure is performed at that level. If the block is achieved over the desired level, some complications such as medulla spinalis injury, severe hypotension and bradycardia can develop (2-4). Hypotension, which is particularly observed after spinal and epidural anaesthesia administration in advanced aged patients, is correlated with differential blockade level (5). One of the main factors affecting the block level is the level of the vertebral space in which the block is achieved. There are some studies showing that the Tuffier's line can pass at different vertebral levels in the elderly and female patients (6). Some studies suggest that the level increases with increasing age, and it is lower in the females (6-9). In this study, the correlation between variations in ages and genders and the level of the Tuffier's line was radiologically evaluated.

Methods

This study was conducted in accordance with the principles of the Helsinki Declaration after receiving an approval from the Ethics Committee of the İzmir Bozyaka Education and Research Hospital on 27th March, 2013 (Decision no: 6). A

Address for Correspondence: Dr. Burcu Özalp Horsanalı, İzmir Bozyaka Eğitim ve Araştırma Hastanesi, Anesteziyoloji ve Reanimasyon Kliniği, İzmir, Türkiye Phone: +90 232 250 50 50 E-mail: burcuhorsanalı@hotmail.com

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total of 590 patients with the recordings of anteroposterior (AP) pelvic radiographs taken in the Orthopaedic Clinic of the İzmir Bozyaka Education and Research Hospital during a 3-year period between January 2010 and April 2013 were examined retrospectively. Patients older than 18 years whose AP pelvic radiographs had been taken in the supine position with the lower extremities lying horizontally on a flat surface without any height difference between the head and the body were included in the study. An experienced radiologist evaluated whether AP pelvic radiographs had been appropriately obtained or not. Patients with vertebral compression fracture, laminectomy, sacralisation, lumbarisation, scoliosis, or similar spinal deformities were excluded from the study. Moreover, radiographs that were found to be inappropriate for evaluation by the radiologist because of reasons such as x-ray dosage and placement of wrong cassette were also excluded.

To radiologically determine the vertebral level of the Tuffier's line in AP pelvic radiographs, the vertebral level at which the line joining the highest points of the crista iliaca passed was identified by the radiologist. Considering that the Tuffier's line joined with the vertebral column (vertebral corpus or intervertebral space) in the pelvic radiographs, the following three levels were determined: L4 vertebral corpus, L4-L5 intervertebral space and L5 vertebral corpus. Patients' genders, ages and vertebral levels at which the Tuffier's line passed were recorded. Based on these data, the correlation between advanced age and gender and the level of the Tuffier's line was evaluated.

For determining the correlation between age and the level of the Tuffier's line, patients were divided into groups according to the mean ages. Therefore, age distribution of patients was according to 10-year periods, and the patients included in each decade were classified as a group. A total of eight groups were formed in this manner (group 1: 20-29 years, group 2: 30-39 years, group 3: 40-49 years, group 4: 50-59 years, group 5: 60-69 years, group 6: 70-79 years, group 7: 80-89 years and group 8: 90-99 years).

Statistical analysis

In this study, continuous variables were expressed in mean±standard deviation as descriptive statistics and categorical variables were expressed in frequency and related percentage values. Chi-square test was used in intergroup comparisons of categorical variables. Statistical significance value was accepted to be $p<0.05$. Statistical analyses of data were performed using the SPSS (Statistical Package for Social Sciences for Windows, Ver. 18.0; New York, USA) software.

Table 1. Distribution of patients according to age groups.

Age range	Number of patients (n)	Patient percentage
20-29	57	9.7
30-39	61	10.3
40-49	78	13.2
50-59	82	13.9
60-69	82	13.9
70-79	95	16.1
80-89	93	15.8
90-99	42	7.1

Results

A total of 590 patients were included in this study. Of these patients, 273 (46.3%) were males and 317 (53.7%) were females.

With regard to the evaluation of the distribution of vertebral levels at which the Tuffier's line passed in all the patients, it was observed that the line passed at the level of L4 vertebral corpus in 260 patients (44.1%) through the L4-L5 intervertebral space in 233 patients (39.5%) and at the level of L5 vertebral corpus in 97 patients (16.4%).

The distribution of patients according to age groups is presented in Table 1.

The correlation between the vertebral level of the Tuffier's line and the mean age of the groups was assessed for each decade of age group. The vertebral levels at which the Tuffier's line passed are presented in Table 2 according to age groups. No significant correlation was found between age groups and vertebral levels of the Tuffier's line ($p=0.939$).

The vertebral levels of the Tuffier's line according to genders were determined to detect the correlation between the vertebral level of the Tuffier's line and gender.

Of the 273 male patients included in this study, the Tuffier's line passed through the L4 vertebral corpus in 145 patients (53.1%), L4-L5 intervertebral space in 107 patients (39.2%) and L5 vertebral corpus in 21 patients (7.7%). In contrast, of the 317 female patients, it passed through the L4 vertebral corpus in 115 patients (37.8%), L4-L5 intervertebral space in 126 patients (40%) and L5 vertebral corpus in 76 patients (22.2%) (Figure 1). It was found that the Tuffier's line passing through the L5 vertebral corpus level was statistically significant in female patients ($p=0.00$). The rate of the Tuffier's line passing through the L5 vertebral corpus level was observed to be significantly higher in female patients than in male patients, but this difference was not associated with age ($p=0.939$) (Figure 1).

Table 2. Distribution of patients according to age range and vertebral levels

Age group	Level						Total
	L4 (n)	L4 (%)	L4-L5 (n)	L4-L5 (%)	L5 (n)	L5 (%)	
20-29	23	389	25	4.23	9	1.52	57
30-39	26	440	26	4.40	9	1.52	61
40-49	35	593	31	5.25	12	2.03	78
50-59	34	576	34	5.76	14	2.37	82
60-69	33	559	36	6.10	13	2.20	82
70-79	49	830	35	5.93	11	1.86	95
80-89	44	745	27	4.57	22	3.72	93
90-99	16	271	19	3.22	7	1.18	42
Total	260	4406	233	39.49	97	16.44	590

Figure 1. Distribution of the levels of Tuffier's line according to gender (%)

Discussion

In this study conducted for evaluating the correlation between the level of the Tuffier's line and the age and gender, it was detected that the Tuffier's line mostly passed through the L4 vertebral corpus level in males and the L5 vertebral corpus level in females. It was also found that the Tuffier's line passing through the level of L5 vertebral body was significantly higher in female patients, but this difference was not correlated with advanced age.

In line with these findings, Snider et al. (7) conducted a study to find the relationship between the line joining iliac cristae and gender, height, weight and body mass index (BMI). They evaluated 200 lumbar radiographs obtained in the standing position and 60 lumbar radiographs obtained in the prone position. At the end of the study, they revealed that the Tuffier's line frequently passed through the L4 vertebral corpus or the lower margin of the L4 corpus in male patients and through the L5 vertebral corpus or upper margin of the L5 corpus in female patients. They reported that the level of the Tuffier's line differed with respect to the gender, but it displayed no correlation with weight and BMI.

In another study performed with 58 cadavers, it was revealed that the Tuffier's line frequently passed through a lower vertebral level in female patients than in male patients (8).

The fact that the Tuffier's line passes through a lower vertebral level in females than in males independent of age can be explained with the difference between the anatomic structures of the pelvic bones in females and in males. The ala ossis ilii part of the os ilium, which is one of the bones forming the structure of the pelvis, leans more towards the lateral side, and the iliac cristae are less curved and the major pelvis has a broader and shallower structure in women (10). Because of these anatomic differences, the vertical height of the part of the iliac bone above the level of sacroiliac joint can be lower in females. As a result, the highest point of the crista iliaca can end at a lower vertebral level in women than in men, and this can cause the Tuffier's line to pass through a lower vertebral level.

In this study, it was found that the lumbar vertebral level through which the Tuffier's line passed was lower in female patients (L5 vertebral corpus). However, it was observed that this vertebral level, which differed depending on the gender, displayed no correlation with age; its distribution was similar in all patient groups between 20 and 99 years. In contrast, in some studies, it was reported that the level of the Tuffier's line was correlated with age and the Tuffier's line passed through a higher level at advanced age (6, 9).

In the study by Rahmani et al. (6) in which they evaluated (AP) lumbosacral radiographs of 189 patients, it was revealed that the Tuffier's line passed through a higher level in males than in females, which is consistent with our results. In addition, they detected that the level of the Tuffier's line was correlated with age, and it passed through a higher level at advanced age.

In another study evaluating the lumbar MR images of 690 patients, it was reported that the conus medullaris and the Tuffier's line passed through a lower level in female patients than in male patients, and the Tuffier's line passed through a higher level in correlation with increased age (9). This was attributed to the fact that the presence of osteoporosis or age-related vertebral deformities in elderly patients led to height loss in the vertebral corpus and caused the level of the Tuffier's line to rise (11-13).

Tuffier's line is one of the simpler and popular markers used for defining the lumbar vertebral level during spinal block (14). The level of the Tuffier's line determined by physical examination before intervention in patients who will be undergoing neuraxial block is accepted to pass through the L4 vertebral corpus or L4-L5 intervertebral space. However, as stated in many different studies, this level can differ depending on many factors such as age, gender, BMI, vertebral deformity and bone diseases (6-9, 11-13, 15).

Knowing the exact level of the Tuffier's line is important for the prevention of complications, including hypotension

and bradycardia, that can develop in association with high-neuraxial block, particularly in patients with cardiovascular system and respiratory system diseases as well as for the formation of sensory and motor block at that level, thereby allowing surgery to be performed (5).

Because the clinical use of the Tuffier's line requires the palpation of subcutaneous fat tissue with different thickness, it can cause high localisation of the Tuffier's line, particularly in obese patients (15). In addition, women have higher body mass index than men. The determination of the Tuffier's line through palpation in obese individuals can be more difficult because of the increased subcutaneous fat tissue (16). After the palpation of the upper margin of the crista iliaca, the intervertebral space that is defined with a line drawn from the palpated region cannot be reliable because it can be 1-or-2-level higher than the level supposed by anaesthesiologists (17). It was observed that when anaesthesiologists used the palpation technique for identifying the intervertebral space, the location of the space was correct in 29% of the patients, but the intervertebral space determined via palpation was higher than the real space in 68% of the patients (18). In another study, it was found that palpation was successful in 30% of the cases, but the intervertebral space was wrongly defined to be at a higher level in 27% of the cases (19).

In this study, because AP pelvic radiographs obtained for determining the level of the Tuffier's line were evaluated retrospectively, some parameters, such as height, weight and BMI, could not be reached. Therefore, the correlation between the Tuffier's line and height, weight and BMI was not evaluated.

Conclusion

It should be kept in mind that the vertebral level of the Tuffier's line, which is frequently used in clinical practices, can pass through different points from the accepted one depending on various factors. Therefore, particularly in female obese patients under high risk of cardiac and respiratory system diseases, the vertebral level of the Tuffier's line should be determined definitely via a radiological examination, such as AP pelvic radiograph, in addition to physical examination to reduce the risk of complications that can develop in association with high spinal blockade after regional anesthesia administration and to obtain the spinal block level that will allow surgical procedure.

Ethics Committee Approval: Ethics committee approval was received for this study from the ethics committee of İzmir Bozyaka Training and Research Hospital (27.03.2013).

Informed Consent: We analyzed the patient's radiological X-rays from our hospital's patient recording system, retrospectively. So, we did not take acknowledgement form from the patients.

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