COMPARATIVE STUDY BETWEEN ULTRASOUND DETERMINATION AND CLINICAL ASSESSMENT OF THE LUMBAR INTERSPINOUS LEVEL FOR SPINAL ANESTHESIA

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Abstract

Background: The aim of the current study is to compare the accuracy of the ultrasound (US) versus clinical assessment for determination of the spinal level, using X-ray as the Gold Standard for control.

Methods: 200 patients were randomized into two equal groups. Patients in the Clinical Group were examined by landmarks to assess the Assumed Clinical Tuffier's Line, and then by fluoroscopy to determine the True Clinical Tuffier's Line. Patients in the Ultrasound Group were examined by the ultrasound to determine the Ultrasound Tuffier's Line. The results of both groups were compared in relation to the plain X-ray, done for each patient, which determined the Radiological Tuffier's Line.

Results: In the Clinical Group, the True Clinical Tuffier's line met the Assumed Tuffier's line in only 12% of the patients. In the remaining patients, wrong leveling ranged from one space above in 80 % to 2 spaces above in 7% and in 1% of patients the line was at L2. In the Ultrasound Group, wrong leveling occurred in 22% of patients. The Ultrasound misidentification was less than one level in 17% and one level in 5% of patients. Ultrasound examination had a true limitation of 2% of patients.

Conclusion: Ultrasound examination of the spine is recommended in patients planned for spinal anesthesia, as it is superior to clinical assessment in identification of the interspinous levels. This will decrease the hazard of spinal cord trauma.

Keywords: Clinical - Determination - Spinal level - Subarachnoid block - Ultrasound.

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Introduction

Neuraxial anesthetic techniques can be challenging because of inter-individual anatomic variability, and imprecise determination of the level of vertebral interspace by physical examination alone which is inaccurate in 70-80% of the time[1,2]. Spinal needle insertion and local anesthetic injection at the wrong lumbar interspace, which is too cephalad, may have been implicated in previously reported injuries to the conus medularis[3]. Permanent neurologic injury is a devastating complication after spinal anesthesia. In a large prospective survey, 0.03% neurologic complication rate was reported, 25% of them were cauda equina[4]. Similar complication rates after spinal anesthesia were reported and the authors concluded that imaging guidance might improve accuracy and safety of needle placement during neuraxial blocks[2].

The aim of the present study is to compare clinical assessment of the spinal level with ultrasound determination for subarachnoid block.

Methods

This is a prospective, randomized and controlled study. It included 200 adult patients, of both genders and of all ASA classes.

After approval of the Local Ethics Committee, patients were randomized into two equal groups. Patients less than 18 years of age, pregnant ladies, those with apparent deformity of the spine and unable to give written consent were excluded from the study.

Group C (Clinical Group)

Patients in this group underwent a plain X-ray of their lumbosacral region and were scheduled for surgery in which fluoroscopy would be utilized. They were examined clinically by an anesthesiologist who was blind to the X-ray findings.

Group U (Ultrasound Group)

All patients in this group also had a plain X-ray of their lumbosacral region. They were examined with ultrasound by the radiologist to identify the different interspinous spaces. The radiologist was blind to their plain X-ray findings.

Examinations

All clinical and US examinations were done in the sitting position, while fluoroscopic examination was done in the supine position.

Plain X-ray of the lumbosacral region (AP view) was used as the "Gold Standard" in the study to determine the level of the intercrestal line, "Radiological Tuffier's Line" (RTL).

The anesthesiologist performed the clinical examination using the highest points of the iliac crests as landmarks. A line was drawn extending between these 2 points (Intercrestal Line). This line, "Assumed Clinical Tuffier's Line" (ACTL), intersected either a spinous process or an interspinous space. The intersection was considered as L4 spinous process or L4-5 interspace, respectively[5-7]. A radio opaque marker was placed in the midline of the ACTL. Fluoroscopic examination of all patients was performed to identify the level of the marker which represented the "True Clinical Tuffier's Line" (TCTL). This fluoroscopic view was examined by a radiologist who was blinded to the whole procedure.

Either the General Electric (Logic 9), Siemens (Antaris) or Aloka (Alfa 10) devices, curved array 2-5MHz, and/ or Linear array 5-10 MHz probes were used. Scanning was performed in transverse axis beginning from the buttock crease moving up in cephalad direction to identify the upper end of the sacrum. The spinous processes and intervertebral spaces of the lumbar spines were counted until the point of crossing of a transverse (intercrestal) line drawn on the back of the patient. This line was determined by ultrasound-guided identification of the highest point of both iliac crests "Ultrasound Tuffier's Line" (USTL). The lumbar spinous process or the intervertebral space opposite this crossing point was identified as the ultrasound level of the intercrestal line. If the upper end of the sacrum could not be conclusively identified, the probe was moved caudally from the level of 12th dorsal spine, using the last rib defined by the US, to determine the USTL.

Statistics

Numerical data were expressed as mean ± standard deviation (M±SD), percentages (%) and numbers. P values <0.05 were considered as statistically significant. SPSS version 11.01 (SPSS Inc., Chicago, IL) was used in the analysis.

Results

The demographical data is presented in Table 1. No statistically significant difference between the 2 groups was noted. All cases of US group were urological. The majority of cases in the clinical group were urological that necessitated intraoperative fluoroscopy.

Table 1
Demographic Data

	Clinical Group (Group C) (n=100)	Ultrasound Group (Group U) (n=100)
Age (Yrs.)	39 ± 12	37±9
Gender (M/F)	94/6	100/0
Height (cm)	164.2 ± 4.3	162.7 ± 4.1
Body Weight (Kg)	72.6 ± 9.8	71.2 ± 10.1
Operations:	94	100
Urological	6 (2 Discectomies, 2 intramedullary nail femur and 2 other fractures)	0
Non-urological		

Vertebral Level

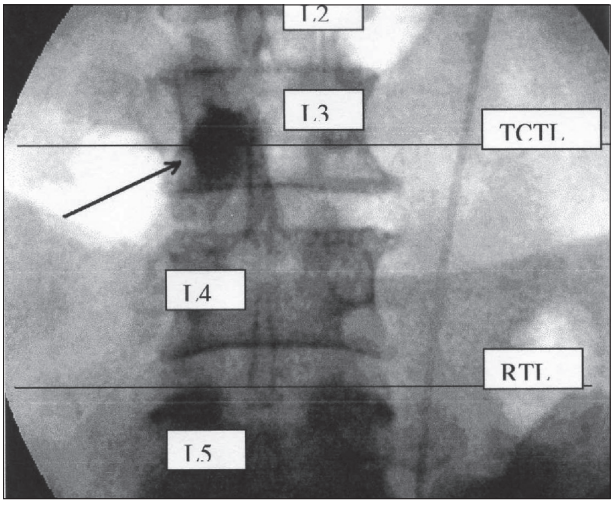
Clinical Group (Group C):

Clinical examination of the 100 patients in Group C (Table 2), showed that only 12% of them met the Assumed Tuffier's Line (L4). In the remaining patients, True Clinical Tuffier's Line ranged from one space above in 80 % of patients (67% in L3-4 and 13% in L3), to two spaces above (L2-3) in 7%, and 1% of patients had their line at L2 (Fig.1). Examination of the plain x-rays of the same group showed that the ATL matched with the RTL (61% in L4 and 25% in L4-5). Plain films of this group showed congenital anomalies in 16% of the patients. Of them, 8% were spina bifida, 4% sacralization, 1% lumbarization, and transitional vertebra in 3%.

Table 2
Distribution of patients of Group C at different spinal levels in Assumed,
True and Radiological Tuffier's Lines (n=100).

Spinal level	Assumed Clinical Tuffier's line	True Clinical Tuffier's line	Radiological Tuffier's line
L2	0	1	0
L2-3	0	7	0
L3	0	13	3
L3-4	0	67	10
L4	69	12	61
L4-5	31	0	25
L 5	0	0	1

Fig. 1
Fluoroscopic spot localizer view with the marker (arrow) for the level of the TCTL identified at L3 spinous process while the RTL at L4-5 interspace representing wrong leveling.



Ultrasound Group (Group U):

In this group, 22 patients showed wrong determination of the spinal level when compared with their plain X-rays. It was less than one level in 17 patients and one level in 5 patients (Table 3 & Fig.2). Out of them, 2 had no obvious cause representing true limitation for US determination, 5 were obese with markedly limited US resolution and 15 patients

had anatomical abnormalities of the spine mostly congenital. Among the abnormalities, 8 were spina bifida, 5 sacralization, one lumbarization, and one laminectomy.

Table 3
Location of Tuffier's Line at different spinal levels by US (USTL) and plain X ray (RTL) in Group U.

Spinal level	Ultrasound Tuffier's line	Radiological Tuffier's line
L2	0	0
L2-3	0	0
L3	4	4
L3-4	16	11
L4	58	69
L4-5	20	14
L 5	2	2

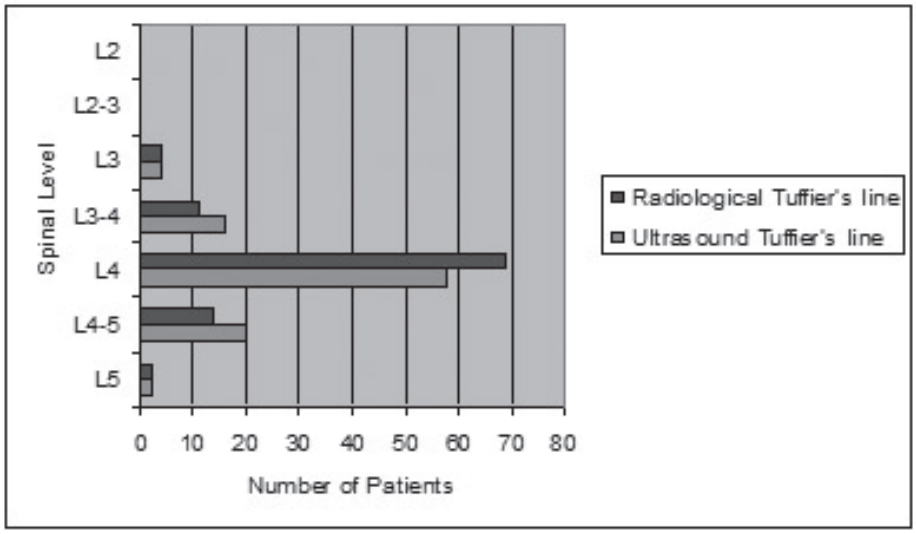
Discussion

The spinal cord terminates below L1 in 19% of people. This, together with the risk of wrong selection of higher interspace for intrathecal injection implies that the spinal cord is more likely at risk of trauma. This is particularly important as clinical experience did not show to improve accuracy of identification of spinal level[8].

The current study showed that 88% of patients had their True Clinical Tuffier's Line higher than the Assumed Tuffier's Line and it was one level above in 80% of the cases. The reason might be due to the original assumption of the clinical assessment which was based on the Radiological Tuffier's Line. Also, the hands of the examiner are not directly on the bone but varying thickness of skin, subcutaneous and muscular tissues is in between. These results were in agreement with those of Broadbent and co-workers who found that in 51% of the times the actual interspinous level was one space above which the anesthetist believed it to be and accuracy was unaffected by patient's position either sitting or lateral decubitus[8].

Comparison of the wrong identification of the spinal level between ultrasound (22%) and clinical assessment (88%) showed that US - guided determination was a better method. Secondly, there was a considerable number (15%) of wrong leveling of two or more levels with clinical assessment, while only one level or less in the case of ultrasound-guided assessment which might decrease the potential hazard to the spinal cord. This was confirmed by a study by Schotterbeck and co-workers in which patients were re-examined by ultrasound to determine the clinical puncture level for spinal anesthesia given previously[9]. The authors found that it was as assumed in 36.4% of the patients and in almost 50% of patients it was more cephalad. Factors including, level of anesthetist's experience, BMI, and spinal pathology did not seem to

Fig. 2
Location of Tuffier's Line at different spinal levels by US (USTL) and plain X ray (RTL) in Group U.



influence the frequency of errors**.**

In a disagreement with Schotterbeck et al., the main reason for US misidentification in the current study was congenital anomalies. Spina bifida was the most common. Wrong leveling was due to the wide separation of the spinous elements and/or absent spinous processes. Although the anomaly can be identified by US, still a wrong identification of the spinal level occurred in 1% of cases. Sacralization and lumbarization of the lumbar vertebrae were the second common cause of wrong leveling, as fusion or separation of L5 and S1-S2 spinous processes lead to misplacing of the intercrestal line. Morbid obesity occupied the third common cause of US-guided misidentification because of the technical difficulty in identifying the spinous processes. In the current study, it formed 18% of the wrongly identified spaces which accounted 4% of the whole series. Studies demonstrated that lumbar landmarks could be correctly identified using the ultrasound in about 76% of the time when they were difficult to palpate in the morbidly obese [10, 11, 12]. Wrong identification by the ultrasound without any anatomical or technical explanation was met in 2% of our cases, which constituted true limitation. In cases with identified congenital anomalies, the ultrasound technique may be modified using the ala of the sacrum as the landmark for S1. This modification may be still misleading in cases of fusion abnormalities, namely, sacralization and lumbarization.

A limitation of this study was the few number of female patients shared. A study including more females is needed due to the difference in shape of the iliac bone than that of the android one.

In conclusion, US examination is recommended in patients planned for spinal anesthesia as it is superior in determining the spinal level to avoid inadvertent trauma to the spinal cord. Further studies of the role of US in evaluating the implications of congenital anomalies on US-guided lumbar puncture are encouraged.

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