DOI: 10.14260/jemds/2014/3087

ORIGINAL ARTICLE

RECOVERY FOLLOWING SUBARACHNOID BLOCK : EVALUATION USING 128 HZ TUNING FORK

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HOW TO CITE THIS ARTICLE:
Goyal Namrata, Luthra Neeru, Sharma Abhinav, Sood Dinesh, Kaul Tej K, Garg Ramneesh. "Recovery following Subarachnoid Block : Evaluation using 128 Hz Tuning Fork". Journal of Evolution of Medical and Dental Sciences 2014; Vol. 3, Issue 31, July 31; Page: 8566-8574, DOI: 10.14260/jemds/2014/3087

ABSTRACT: BACKGROUND: Following spinal anesthesia it is very important to see complete recovery before ambulation and discharge of the patient. Conventional methods to see recovery from spinal block use different types of motor power tests like Bromage score or the Formal motor power test system. **MATERIAL AND METHODS:** A total of one hundred and fifty patients of ASA grade I and II, presenting for lower segment caesarean section under spinal anesthesia were taken up for the study. We compared the use of a 128-Hz tuning fork with the results of conventional evaluation of block recovery. Conventional block recovery testing included Bromage score, Formal muscle power testing according to the British Medical Research Council, pinprick testing, and warm/cold testing. After obtaining base line values, a subarachnoid block was performed and patients were tested every 15 minutes after surgery, till the vibration score of one less than the baseline was achieved. Statistical analysis was performed to compare the results of the different methods to the time at which baseline values of vibration sense were reached. **RESULTS:** At the time vibration sense testing returned to baseline, 100% of the patients had attained Bromage score of 0 with no residual motor block. 98% of the patients regained foot extension and foot flexion strength completely while 92% of the patients showed complete recovery of the quadriceps strength. **CONCLUSION:** Recovery of vibration sense corresponds with recovery of motor block after spinal anesthesia and may serve as an easy means of documenting recovery with a single test before discharge.
KEYWORDS: Ambulation, caesarean section, spinal anesthesia.

INTRODUCTION: Central neuraxial blockade results in sympathetic, sensory and motor block depending upon dose, concentration and volume of local anaesthetic used. Following central neuraxial blockade, autonomic preganglionic B fibers conveying temperature (cold before warm), pinprick, pain, touch, deep pressure and somatic motor are blocked. Fibers conveying vibration sense and proprioceptive impulses are last to be blocked. Recovery from the blockade occurs in the reverse order.[1]

The requirements of safe walking after regional block are muscle power, proprioception and subjective feeling of ability to walk,[2] in addition to vision and an intact vestibular apparatus.[3] In walking epidural analgesia, posterior column impairment is evident by loss of vibration and proprioception sense.[4] These senses are vital for walking and their impairment may undermine safe mobilization.

Early return of motor function with epidural analgesia, leads to false sense of security to walk but actually, patient may fall due to poor coordination of lower limbs because of inadequate posterior column sensations. So, it is very important to see complete recovery following neuraxial blockade for early ambulation and discharge of the patient.

In any case, resolution of motor blockade should occur when vibration sense returns to the baseline after neuraxial blockade. Conventional methods to see recovery from spinal block use different types of motor power tests like Bromage score[5] or the Formal motor power test system of the British Medical Research Council, which are often difficult to perform because of immobilizing dressings from the surgical procedures or associated pains.

Evaluation of vibration sense was traditionally done by a non-graduated 64 Hz tuning fork, but unfortunately it does not provide the degree of dysfunction quantitatively.[6] 64 Hz graduated tuning fork by Rydel and Seiffer in 1903 has been proved reliable for quantifying impairment of vibration sense but it is best quantified with a larger tuning fork that vibrates at 128 Hz. In our study we tested the efficacy of vibration sense using 128 Hz Rydel Seiffer tuning fork as a substitute for the assessment of the motor block recovery after spinal anesthesia in patients undergoing caesarean section.

MATERIAL AND METHODS: After approval of hospital ethics committee one hundred and fifty patients of American Society of Anesthesiologists (ASA) grade I & II, presenting for lower segment caesarean section, under spinal anesthesia, were taken up for the study. Patients with peripheral neuropathies and myopathies were excluded from the study. A written informed consent was taken from all the patients.

Vibration sense testing was performed with a 128-Hz tuning fork and documented by a single investigator using an 8-point numeric scale. The 8/8 scale is a semi-quantitative measurement of the intensity of the applied vibration and may be seen on the tuning fork as shown in Fig. 1. The tuning fork has two scales, one white and one black, applied to the ends of the fork. When the tuning fork is struck and vibrates at a high level, the marks on the scale are not clearly visible. As the vibration of the tuning fork becomes slower, both the black and white scales gradually come into focus and the numeric level becomes visible.

This begins with the lowest value (0/8) and progresses to the highest (8/8). The patients are instructed to inform the investigator as soon as they no longer feel the vibration, and the value from 0 to 8 is recorded. A value of 8/8 or 7/8 (almost no residual vibration of the tuning fork) is considered to be normal, and lower values (high levels of vibration of the tuning fork) indicate an impairment of vibration sense.

Vibration sense was tested 3 times at each measurement at the terminal inter phalangeal joint of the great toe and the medial malleolus and calculated as the mean. The sound of the tuning fork cannot be heard more than 100cms distance from the ear, and the patients were asked to look at the ceiling to make visual bias impossible.

We also documented motor block using a modified Bromage Score (Table 1) and Formal motor power testing of the quadriceps muscle and flexion and extension of the foot using the modified grading system of the British Medical Research Council 1978 (Table 2).

After obtaining baseline values, all patients received subarachnoid block from a single anesthesiologist using 2 to 2.5mL of 0.5% bupivacaine using 26-gauge spinal needle at the L3/4 level in the left lateral position under aseptic conditions.

Evaluation of vibration sense and motor block was performed every 15 minutes (except during the period of surgery) until all variables returned to baseline. All observations were tabulated and results were statistically analyzed using z test with a significance level of $P < 0.05$.

RESULTS: This prospective study included a total of one hundred and fifty patients of ASA physical status I and II, presenting for lower segment caesarean section under spinal anesthesia. There were 130(86%) ASA grade I patients and 20 patients (14%) belonging to ASA grade II [Table 3].

Baseline values of vibration sense using 128 Hz Rydel Seiffer tuning fork and formal motor power of quadriceps muscle, foot flexion and foot extension using modified grading system of Formal motor power testing (British Medical Research Council, 1978) were recorded a day prior to surgery [Table 2]. Vibration sense perception less than 7 was considered as neuropathy and these patients were excluded from the study.

Immediately after surgery, vibration score using 128 Hz Rydel Seiffer tuning fork, Bromage score, and motor power of quadriceps muscle, foot flexion and foot extension using modified grading system of Formal motor power testing (British Medical Research Council, 1978) were recorded every 15 minutes, till the vibration score one less than the baseline value was achieved.

Figure 2 shows graphical representation of the percentage of patients showing Bromage score recovery, quadriceps recovery, and foot extension and flexion recovery when vibration sense returned to baseline.

DISCUSSION: Our study shows that the time when vibration sense returned to baseline, 100% of patients had a Bromage score of 0 and 98%of the patients regained foot extension and foot flexion strength completely and there was no statistically significant difference between them ($p>0.05$). The complete recovery (grade V) of quadriceps strength was recorded in 92% of the patients and its difference with respect to vibration sense recovery was statistically significant ($p<0.05$).

Spinal anesthesia was first used by Bier for relief of surgical pain. The residual effect of the block on motor, sensory and sympathetic nervous system is a troublesome complication of spinal anesthesia. Following subarachnoid block, impairment of these sensations leads to poor co-ordination of lower limbs, delaying safe and early mobilization of the patient.

Alpha motor neurons are responsible for conducting motor impulses at 70 to 120 m/s and A-beta or A-alpha fibers with a similar conduction speed are used in the afferent pathway of vibration sense and proprioception. Both types of nerve fibers are of similar diameter and surrounded by a comparable amount of myelin.

There is some controversy as to whether motor neurons and vibration sense fibers are blocked to the same degree[3] or if afferent fibers are even more sensitive to local anesthetics because of a higher baseline discharge rate.[4] In any case, resolution of motor block should occur when vibration perception returns to baseline after regional anesthesia.

The relation among motor function, balance and postural stability is complicated. Maintaining balance without falling requires sensory inputs from visual, somatosensory and vestibular inputs by the brainstem and cerebellum.[7] This sensory information is updated and analyzed by the brain to maintain balance and to control body position.[8]

The dominant sensory input to control balance comes from the lower limbs. Chronic vestibular disorders compensate by other systems but it is not known whether this occurs following regional anesthesia also as time may be insufficient for the adjustments in balance and posture to occur.[9]

Early ambulation after surgery is recommended, which in turn depends upon complete recovery and maintenance of accurate balance. Different measures of ambulatory readiness assessed

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are clinical, i.e., the Romberg test and patient performance of various maneuvers indicative of adequate motor function, including the straight leg raising test, deep knee bend and heel-to-shin touch. Evaluation of these indicators is subjective, potentially resulting in variable definitions of return of motor function, making it difficult to predict full recovery.

There is a limited literature on objective assessment of postural functions after spinal anesthesia. Mandee, investigated the optimum time to encourage ambulation correlating with the time to sit without adverse events in patients receiving spinal anesthesia.[10]

Almetwalli, used quantitative measurements of the degree of recovery of the motor power of the knee, hip, or ankle flexors and found them to be more accurate and superior to Bromage score ($p< 0.001$), as predictors of patient's ability to safely ambulate after spinal anesthesia.[11] A force transducer has been used before and after epidural analgesia was established and modified it to measure power of hip adduction quantitatively and compared with the modified Bromage scale.[12]

Charles compared clinical markers of gross recovery with objective data of functional balance after spinal anesthesia. He found that walking balance remained impaired long after (90–120 min) clinical criteria for functional recovery from spinal anesthesia were met. So the ability to walk without assistance after spinal anesthesia requires a longer recovery period than predicted solely by gross motor recovery.[13]

In order to investigate concerns that dorsal column function, which is important in maintaining balance, is impaired after spinal and epidural anesthesia, clinical assessment of lower limb proprioception and vibration sense has been evaluated in various studies. A 128 Hz tuning fork is commonly used in the diagnosis of dorsal horn dysfunction and polyneuropathy as it determines the ability of a patient to discriminate various vibration intensities and for quantifying impairment of vibration sense.[14]

Abrahams M studied sixty primigravidae for labor epidural analgesia using assessment of dorsal column sensory function including vibration sense, distal proprioception and the Romberg test before catheter insertion.[15] He found addition of 100 µg fentanyl to 15 mg of epidural bupivacaine gave good control of labour pain with no motor block along with preservation of dorsal column sensory function.

Parry evaluated dorsal column functions after epidural and spinal blockade and their implications for safety of walking following low dose regional analgesia for labour.[8] They concluded that abnormal dorsal column functions are expected to increase with increasing motor block and both lower limb motor power and dorsal column function should be assessed and shown to be normal before allowing patients to walk at any point.

Similar results were found by Buggy as regards incidence of motor weakness in patients given labour epidural analgesia. [16] Sebastian assessed vibration sense and compared the results with conventional evaluation of block recovery (Bromage Score, Formal muscle power testing according to the British Medical Research Council, pinprick testing and warm and cold testing).[17] He observed that, recovery of vibration sense corresponded with recovery of motor block after epidural anesthesia and may serve as an easy means of documenting recovery with a single test before discharge.

We used a low dose 10mg solution of bupivacaine. Our goal was to produce satisfactory surgical anesthesia while reducing the likelihood of residual postoperative motor block, thereby minimizing the time to adequate motor function and ambulation. Our results are comparable to that of Sebastian, although the study was on epidural but pattern of vibration sense and motor block recovery was same in both techniques. We recorded our observations every 15 minutes till vibration score one less than baseline value, as compared to 30 minutes interval taken by Sebastian, since onset and recovery of anesthesia occurs very fast in subarachnoid block as compared to epidural anesthesia.

Recovery of motor power corresponds to vibration sense recovery and there was no significant statistical difference between them ($p < 0.05$). However, minimal and clinically negligible residual motor weakness was noted in 8% of the patients (quadriceps strength grade IV) and this difference with vibration sense recovery was statistically significant ($p < 0.01$). Although recovery of vibration sense was taken as an end point, it was observed that complete motor recovery of patients with residual weakness occurred in next five to ten minutes.

CONCLUSION: To conclude it is perhaps more relevant to consider not when the patients are able to walk but if they are able to do so with the same degree of safety as before the block had been initiated. Recovery of vibration sense is as sensitive as Bromage scale and Formal motor power of quadriceps muscle, foot flexion and foot extension.

It may serve as a reliable substitute for motor recovery testing in situations where there is difficulty in assessment of motor power like patients having pain on performing Bromage. It should be included in criteria for early ambulation of the patients following spinal anesthesia as lower degree of muscle weakness cannot be fully detected by the Bromage test.

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DOI: 10.14260/jemds/2014/3087

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Scores	
0	No motor block
1	Inability to raise extended legs
2	Inability to flex knees
3	Inability to flex ankle joints

Table 1: MODIFIED BROMAGE SCALE

Scores	
0	No muscle contraction at all
1	Visible muscle contraction but no movement
2	Movement without influence of gravity
3	Movement against gravity
4	Movement against resistance
5	Normal strength

Table 2: MODIFIED GRADING SYSTEM FOR FORMAL MOTOR POWER TESTING

(British Medical Research Council 1978)

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		A. S.A		Total	p value
		I	II		
Baseline Vibration score	7/8	58	15	73	0.493
		79.5%	20.5%	100.0%	
	8/8	72	5	77	
		93.5%	6.5%	100.0%	
Total		130	20	150	
		86.7%	13.3%	100.0%	

Table 3: DISTRIBUTION OF PATIENTS ACCORDING TO ASA PHYSICAL STATUS

Baseline vibration Score	8/8	7/8
No. of Patients (percentage n=150)	77 (51.33%)	73 (48.67%)

Table 4: DISTRIBUTION OF PATIENTS ACCORDING TO BASELINE VIBRATION SCORE

Baseline vibration score	8/8	7/8	8/8 or 7/8
Total number of patients	77	73	150
No. of patients with bromage score recovery	77 (100%)	73 (100%)	150 (100%)
No. of patients with quadriceps recovery	70 (91.9%)	68 (93.15%)	138 (92%)
No. of patients with foot extension recovery	75 (97.41%)	72 (98.64%)	147 (98%)
No. of patients with foot flexion recovery	76 (98.71%)	71 (97.27%)	147 (98%)

TABLE 5: ANALYSIS AT THE TIME VIBRATION PERCEPTION RETURNED TO BASELINE

Z VALUES FOR COMPARISON:

	Bromage Score	Quadriceps strength	Foot extension strength	Foot flexion strength
Vibration Sense	0	3.53	1.81	1.81

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FIG. 1: 128-Hz RYDEL-SEIFER TUNING FORK USED FOR VIBRATION SENSE TESTING

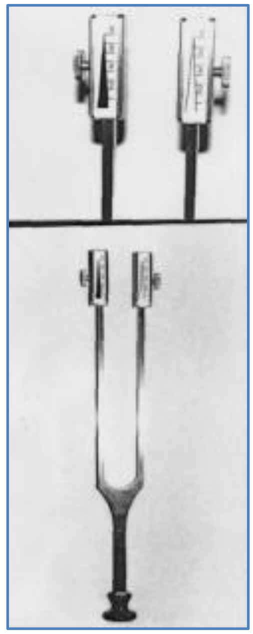

Figure 1

FIG 2: GRAPHICAL REPRESENTATION SHOWING BROMAGE SCORE RECOVERY, QUADRICEPS RECOVERY, FOOT EXTENSION AND FLEXION RECOVERY.

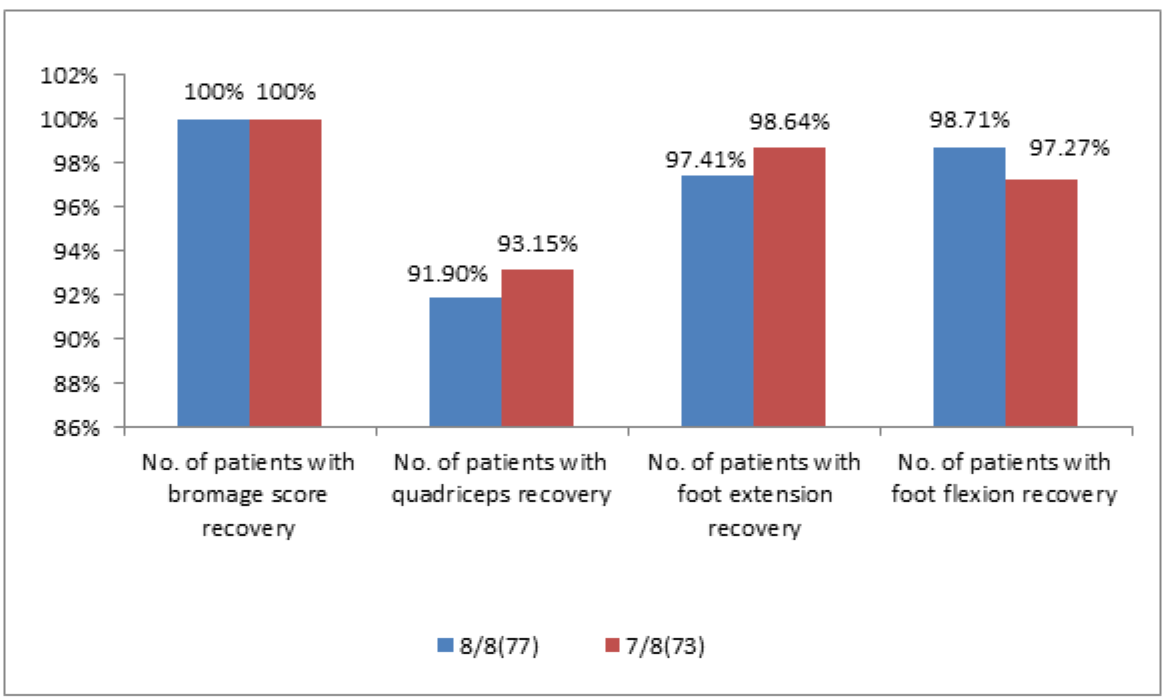

Figure 2

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Date of Submission: 03/07/2014.
Date of Peer Review: 04/07/2014.
Date of Acceptance: 17/07/2014.
Date of Publishing: 29/07/2014.