

## Research Article

# Assessment of Finger Proprioception and Lateral Pinch Strength in Amateur and Professional Guitarists

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## I N F O

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## A B S T R A C T

**Background:** Guitarists use complex and different movement patterns in both hands simultaneously. Applying pressure on the strings and strumming both require good strength whereas playing the melody on the fret-board demands good proprioception. There is a need to find out if guitarists perform functionally well with respect to pinch strength and proprioception which are prerequisites for playing the guitar. Therefore, the aim of the study is to assess and compare finger proprioception and pinch strength in amateur and professional guitarists.

**Methodology:** A cross sectional study was conducted on 50 amateur and 50 professional guitarists from Mumbai. A self-made questionnaire including their demographic data was asked to be filled. Proprioception was measured using the pinch aperture proprioception device and lateral pinch strength was measured using the Jamar® Hydraulic Pinch Gauge. The average of 3 trials was taken for finger proprioception and lateral pinch strength. The data obtained was then taken for further analysis.

**Result:** Professional guitarists had better finger proprioception (p value = 0.0001 for both right & left hands) and lateral pinch strength (p value = 0.0159, 0.0001 for the right & left hand respectively) than amateur guitarists. Also, the left hand had better finger proprioception (p value < 0.0001, 0.0059 for amateur & professional guitarists respectively) and right hand had better lateral pinch strength (p value = 0.0001 for both professional and amateur guitarists) in both professional and amateur guitarists.

**Conclusion:** Professional guitarists had significantly better finger Proprioception and lateral pinch strength as compared to the amateur guitarists.

**Keywords:** Musicians, Finger Proprioception, Pinch Strength, Guitarists

## Introduction

In this day and age, more people want to learn to play

an instrument as compared to before. This may be due to various reasons such as reducing stress, recreational

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purposes, career, etc. Musicians are categorised in amateurs and professionals depending on their skill and reason for instrument playing. Music is a source of employment for a professional musician, while, an amateur musician does music in the free time whether paid or unpaid.<sup>1</sup>

Playing a musical instrument requires the integration of multimodal sensory and motor information.<sup>2</sup> Each category of instruments has its own physical demands. Playing any instrument demands repetitive and precise movements in extended durations of non-ergonomic posture such as while playing the guitar which belong to the strings family. Guitar playing appears effortless; however, there are a great deal of physical demands associated with it. The right hand does the strumming and/ or picking of the strings, and fingers of the left hand are used for fretting the strings, i.e., controlling the acoustic range of the instrument by varying effective string length.<sup>3,4</sup> The energy put into the string by the guitarist's finger accounts for the sound produced.<sup>5</sup>

Musicians need a meticulous control of movement while playing their instrument, which demands good proprioception. "Proprioception is the awareness of position and movement of the body and its segments without visual cues."<sup>6</sup> The skin, joints, ligaments, tendons, and muscle contain mechanoreceptors or proprioceptors which derive proprioceptive feedback signals.<sup>7</sup> String players press the string in a highly precise manner so that the right pitches are achieved consistently<sup>8</sup> for which pinch strength and proprioception are of utmost importance. Developing proper motor programs between the brain and the hands so as to execute different patterns and techniques with paramount efficiency is vital for a guitarist or any musician.<sup>9</sup> Playing different sequences in both hands simultaneously for a guitarist requires precise functional coordination of both hands.<sup>10</sup>

Due to the above-mentioned reasons there is a need to find out if guitarists perform functionally well with respect to pinch strength and proprioception which are both prerequisites for playing the guitar. Since there is a paucity of literature with respect to pinch and proprioception in guitarists, therefore, the aim of the study is to assess and compare finger proprioception and pinch strength in amateur and professional guitarists.

## Methodology

A cross sectional study was conducted in a 6 month period from August 2019 to January 2020 on 50 amateur and 50 professional guitarists recruited from music schools, academies and bands in Mumbai. The subjects were aged between 18 to 35 years were right hand dominant and had no past history of any musculoskeletal or neurological problem. The nature and purpose of study was explained

and prior consent was obtained from the participants. A self-made questionnaire (see Annexure) including their demographic data was asked to be filled. The proprioception was measured using the Pinch aperture proprioception device<sup>7</sup> and lateral pinch strength was measured using the Jamar<sup>®</sup> Hydraulic Pinch Gauge (Sammons Preston, Inc.).<sup>11</sup>

## Statistical Analysis

Means±Standard Deviations (SD) were used to describe variables. Normality of the data was verified using the Kolmogorov-Smirnov test. Paired t-test and unpaired t-test was used for within group analysis and between group analysis respectively. Significance level was set at <0.05. Confidence interval was set at 95%.

## Procedure

Institutional ethics committee approval was taken prior to the beginning of the study. The subjects falling into the inclusion and exclusion criteria were taken for the study. A consent form stating the purpose of the study was taken. The self-made questionnaire including their demographic data was asked to be filled by the study samples. The procedure was then explained to them.

## Finger Proprioception

Finger proprioception was measured using the pinch aperture proprioception device.<sup>14</sup> This included a goniometer with its fulcrum fixed on a cardboard box (Figure 1a). The goniometer arms included circular pads for the placement of the tips of the thumb and first finger. The subject was asked to rest their hand on the table and to hold the perpendicular pads, using their index finger and thumb. Subjects were familiarized with the device and then performed two practice trials during which the index finger and thumb were moved passively by the examiner from the starting position of 30° to the target position of 15° with their eyes closed. In these practice trials, the subjects had to memorize that position. During the testing, the examiner moved the goniometer arms to the starting position (30°) and instructed the participant to pinch their fingers actively trying to reproduce the target position (15°) without visual feedback. The average of 3 trials was collected for further analysis.<sup>12</sup>

## Later Pinch Strength

The lateral pinch strength was measured using the Jamar Hydraulic Pinch meter<sup>13</sup> (Figure 1b). The subject had to be seated upright. The testing arm was placed on a table with elbow flexed at 90°, wrist in neutral. The pinch gauge was placed between the flexed PIP joint of the index finger and thumb. The subject was asked to squeeze, hold and then release. Average of 3 trials was collected for further analysis.<sup>13</sup>



**Figure 1(a): Measurement of finger proprioception using the Pinch aperture proprioception device**

**Figure 1(b): Measurement of lateral pinch strength using the Jamar® Hydraulic Pinch Gauge**

**Figure 1. Outcome measures - (a) Pinch aperture proprioception device and (b) Jamar® Hydraulic Pinch Gauge**

**Result**

100 guitarists from Mumbai were assessed for finger proprioception and lateral pinch strength. Table 1, represents the demographic characteristics of the professional and amateur guitarists. The guitarists playing styles were confined to rhythm, lead and bass. Amateur guitarists played only for recreational purposes. There were 35 students and 14 self-trained amateur guitarists. The professional guitarists played for a living. There were 6 guitar tutors, 36 band members and 8 choir members.

**Table 1. Demographic Data of amateur and professional guitarists**

	Amateur Guitarists	Professional Guitarists
No. of Subjects	50	50
Age (mean±SD)	21.92±3.78	23.2±4.69
Years of playing (mean±SD)	1.6±1.16	7.98±3.44
Age of Commencement of playing (mean±SD)	19.78±4.13	14.98±4.44
Hours of playing per week (mean±SD)	2.42±1.45	7±3.11
Gender	Male: 35 Female: 15	Male: 47 Female: 3

Paired t test was used for comparison between professional and amateur guitarist’s finger proprioception and lateral pinch strength in left and right hand. Between group analysis showed that professional guitarists had better finger proprioception (p=0.0001 for both right & left hands) and lateral pinch strength (p=0.0159, 0.0001 for the right & left hand respectively) than amateur guitarists (Table 2).

Unpaired t test was used for comparison of right and left hand finger proprioception and lateral pinch strength in professional and amateur guitarists. Within group analysis

shows that, the left hand had better finger proprioception (p=0.0001, 0.0059 for amateur & professional guitarists respectively) and right hand had better lateral pinch strength (p=0.0001 for both professional and amateur guitarists) in both professional and amateur guitarists (Table 3).

**Table 2. Comparison between professional and amateur guitarist’s (MEAN±SD) finger proprioception and lateral pinch strength in left and right hand (between group analysis)**

		Amateur Guitarist	Professional Guitarist	p-value
Finger Proprioception (degrees)	Right Hand	19.65±1.623	17.13±2.784	<0.0001
	Left Hand	17.99±2.033	16.14±1.311	<0.0001
Lateral Pinch strength (kilogram force)	Right Hand	14.38±3.126	15.69±2.082	0.0159
	Left Hand	11.54±2.443	13.91±2.123	<0.0001

**Table 3. Comparison of right and left hand finger proprioception and lateral pinch strength (Mean±SD) in professional and amateur guitarists (within group analysis)**

		Right hand	Left hand	p-value
Finger Proprioception (degrees)	Amateur Guitarist	19.65±1.623	17.99±2.033	<0.0001
	Professional Guitarist	17.13±2.784	16.14±1.311	0.0059
Lateral Pinch strength (kilogram force)	Amateur Guitarist	14.38±3.126	11.54±2.443	<0.0001
	Professional Guitarist	15.69±2.082	13.91±2.123	<0.0001

## Discussion

The aim of the study was to assess finger proprioception and lateral pinch strength in amateur and professional guitarists.

The first objective was to compare the finger proprioception between amateur and professional guitarists (Table 2). According to the result obtained, the professional guitarists had better finger proprioception than the amateur guitarists with respect to both right and left hands. In a study, they found out that in professional musicians, the pattern of sensorimotor organization is organized less differentially than in non-musicians. Motor control of adjacent fingers may be facilitated due to this pattern, (e.g. for the playing of fast passages) which may prove as an advantage.<sup>14</sup> Increased finger proprioception might also account for the years of training and difference in weekly practice intensity between the amateurs and professionals. A similar study suggested that there could be enhancement or preservation of domain-general, cognitive control abilities in older adults owing to sustained music-making ability and expertise.<sup>15</sup> A study comparing gray matter volume in professional and amateur musicians found that there was an increased gray matter volume in professional musicians in peri-rolandic, premotor region, superior parietal region and inferior temporal gyrus bilaterally which which are associated with bimanual finger movements, motor learning and skill acquisition.<sup>2</sup> All of these are significant for a musician.

When the finger proprioception is compared between right and left hands of both amateur and professional guitarists, the left hand seems to have greater finger proprioceptive ability (Table 3). In guitarists, the left hand is the so-called hand of technique. The fingers have to aim at the correct note on the fret-board where there are a hundred possible targets<sup>16</sup> which demands a good proprioceptive input. This could account for the years of training or the age at which the guitarists commenced playing the guitar. The result of the present study are in accordance with study done by author Hortobágyi T et al. that the amount of cortical representation of the digits of the left hand of string players on magnetic resonance was larger than in controls which correlated with the age at which the person had begun to play.<sup>17</sup> Also, it has been observed that, the left hand skills of right-handed musicians outperformed that of right hand non musicians. They showed a reduced degree of right-hand superiority which was mainly due to a left-hand gain and not to a right-hand loss of skill.<sup>18</sup> The left hand melody helps consolidate control of the fingers involved which in turn involves mental anticipation of each movement that presets muscles to aim the finger most accurately.<sup>16</sup>

Another objective was to compare the lateral pinch strength between amateur and professional guitarists (Table 2). Playing the guitar demands intense practice and playing a

repertoire of movement. Each finger is placed and fitted to press the strings at the accurate angle and strength.<sup>19</sup> According to the results obtained, similar to proprioception, the professional guitarists had better lateral pinch strength as compared to amateur guitarists. It has been observed that the finger skill in guitarist is involved with the exchange of paired fingers in a cross-board movement which increases the strength and separation of the fingers.<sup>16</sup> Also, practice sessions for guitarists include hours of repetitive movements such as the strumming action. Professional guitarists in the sample had far more practice or playing time per week as compared to amateur guitarists which would include a repertoire of strumming patterns. The amount of practice required to obtain the desired music is done by optimal loading of the muscles to play the rhythm precisely Muscles adapt and grow and muscle fibres increase in strength when they are pushed just beyond their optimal load, first as the nerve networks that supply the muscles become increasingly efficient.<sup>17</sup>

As far as the differences between the right and left hand are concerned with respect to lateral pinch strength, the amateurs and professionals both had better lateral pinch strength in the right hand i.e. the dominant hand or the strumming hand (Table 3). The act of strumming requires lateral pinch to hold the plectrum in place or to simply strum the strings with the fingers. This strumming action is done continuously by the right hand. The strumming action is also fast paced. A study using surface electromyography (EMG) on the right hand of professional guitarists concluded that a high degree of stability and consistency in terms of muscular activation, was demonstrated with excellent motor control in them.<sup>19</sup>

Therefore, the results of the present study state that, professional guitarists had significantly better finger proprioception and lateral pinch strength than amateur guitarists. Also, with respect to the upper extremities, left hand had better finger proprioception and right hand had superior values for lateral pinch strength in both professional and amateur guitarists.

## Conclusion

Finger Proprioception and lateral pinch strength was better in professional guitarists as compared to the amateur guitarists. Exercise protocol focusing on finger proprioception and all pinch strength should be incorporated as daily routine exercises to meet the demand of the game and to prevent further injuries to hand.

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### Ethical Clearance

Clearance was obtained from the Institutional ethical committee of D.Y. Patil Deemed to be University, School of Physiotherapy, Navi Mumbai.

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**Conflict of Interest:** None

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## Annexures

### Questionnaire

1. Full Name
2. Age
3. Mobile no.
4. Email Address
5. Type of Guitar
  - Rhythm
  - Lead
  - Bass
6. Playing Level
  - Band
  - Orchestra
  - Choir
  - Tutor
  - Student
  - Self-Trained
7. No. of years of playing
8. Age of commencement of playing
9. Hours of playing per week
10. Any known neurological condition? (If yes please mention)
  - Yes \_\_\_\_\_
  - No \_\_\_\_\_
11. Any known musculoskeletal condition? (If yes please mention)
  - Yes \_\_\_\_\_
  - No \_\_\_\_\_
12. Any past injury to the upper limbs? (If yes please mention)
  - Yes \_\_\_\_\_
  - No \_\_\_\_\_
13. Hand Dominance
  - Right
  - Left