Understanding Vrikshasana using body mounted sensors: A statistical approach

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ABSTRACT
Aim: A scheme for understanding how the human body organizes postural movements while performing Vrikshasana is developed in the format of this paper.

Settings and Design: The structural characteristics of the body and the geometry of the muscular actions are incorporated into a graphical representation of the human movement mechanics in the frontal plane. A series of neural organizational hypotheses enables us to understand the mechanics behind the hip and ankle strategy: (1) Body sway in the mediolateral direction; and (2) influence of hip and ankle to correct instabilities caused in body while performing Vrikshasana.

Materials and Methods: A methodological study on 10 participants was performed by mounting four inertial measurement units on the surface of the trapezius, thoracolumbar fascia, vastus lateralis, and gastrocnemius muscles. The kinematic accelerations of three mutually exclusive trials were recorded for a period of 30 s.

Results: The results of every trial were processed using two different approaches namely statistical signal processing (variance and cross-correlation). Conclusions obtained from both these studies were in favor of the initial hypothesis.

Conclusions: This study enabled us to understand the role of hip abductors and adductors, and ankle extensions and flexions in correcting the posture while performing Vrikshasana.

Key words: Abductors and adductors; accelerometers; invertor-evertor mechanism; mediolateral; Vrikshasana.

INTRODUCTION
Yoga has been extensively studied as it has numerous benefits on the human health. Yoga is a paramount tool to improve the mental and physical health of a person and also helps in stretching the muscles of the body. Yoga constitutes of innumerable poses called asanas that invigorate every part of the body, one among which is Vrikshasana, also known as the Tree Pose that stretches the legs, arms, and the back of the performer to help improve balance. The balance in the body is realized by the central nervous system (CNS). This provides a feedback strategy to control the center of gravity (CoG) from tipping off. This feedback strategy constantly is provided to the hip, knee, and ankle whose moments counter act the swaying of CoG. Studies of the postural responses to sudden small and slow external disturbances by support translation in the antero-posterior (A/P) direction found that most people reposition the CoG by swaying as a flexible inverted pendulum primitively about the ankles with little hip or knee motions, this type muscle activation is called as the “ankle strategy.” Similarly, when postural responses to sudden and significant external disturbances by support translation in the mediolateral (M/L) and/or A/P direction found that most people reposition the CoG by swaying about the hip with little or no ankle motion.
motions, this type of muscle activation is called the “hip strategy.”[5]

Even attempting to stand still the body will be subjected to small variations such as vibrations in the M/L and or A/P plane. These minor perturbations do not prove to threaten the equilibrium.[6] The projection of the center of mass can be easily maintained within the area of support bounded by the outer edges of the feet. It has been observed that people with CNS damage find it difficult to stand upright due to excessive sway in the M/L and/or A/P direction(s). According to the standard Tree Pose described in,[7] the participant lift one foot off the ground, eventually working their foot up to their calves, and then above their knees. The pressure of the foot exerted on the inner thigh causes the body reaction force to swing in the M/L direction.

The vast majority of investigations of quiet stance regarding the neuromuscular responses and strategies have been restricted to the sagittal plane.[8,7] However, the underlying motor mechanisms that suggest the hip abductors/adductors in addition to the ankle invertors/evertors control the lateral movement as concluded by Winter DA et al. (1996). Feedback to lateral perturbations has generally been confined to electromyographic responses of ankle joints.[8] M/L changes were controlled by hip muscles while the A/P changes were controlled by the ankle joints. In quiet stance with feet side by side on two force platforms, motor responses in the M/L direction were dominated by the hip load/unload strategy as a result of the hip strategy being orthogonal to the A/P control plane. This is completely independent of the ankle strategy as shown by Winter et al. (1996). Yu et al. (2012).[9] published on the requirements for the performance of the Tree Pose and the One Leg Stand. These requirements were quantified by estimating the net joint moments of force and muscular activation generated. However the success of the methodology adopted by,[10] where they partitioned the ankle and hip mechanisms in the A/P and M/L directions for side-by-side stance is motivation to examine this strategy in other postural positions such as Vrikshasana.

The purpose of this study is to examine the physical demands of Vrikshasana and the correction strategies that are involved while performing the asana also to determine the relative role of each of the hip and ankle strategies when participant perform the asana. This position is chosen to examine the underlying strategies that enable the human body to stand as when compared to the tandem stance. On the basis of the conclusions of Winter et al. (1993), because the CoG of the body is subject to constant change and that the ankle joints are not in line, the domination of the M/L control by hip strategy (adductor/abductor) was hypothesized. Parameters such as cross-correlation have been implemented so as bring out the similarities between the kinematic accelerations observed at the “thigh” and the “ankle” that are two mutually exclusive signals.[10] We have adopted inertial measurement units (IMUs) to record these accelerations generated at the “neck,” “waist,” “thigh,” and the “ankle.” The cross-correlation of these accelerations observed at the thigh and shank over three successive trials is calculated to establish support for the given hypothesis. Apart from using cross-correlation, statistical parameters such as variance are used to bring out significant closure to the above-stated hypothesis.

**Background theory**

The CoG of the body during normal stance ideally lies at the center of the waist [Figure 1]. The reaction force of the CoG lies at the center of the two feet when body weight is distributed equally between the two feet. The variations of the body due to instabilities cause the weight of the body to get distributed unequally between the two feet resulting in a change in the position of the CoG. Depending on the amount of perturbations, the hip and/or the ankle help in regaining the stance by generating a force opposite to that of distress. However, these perturbations are of very small magnitude during tandem when both feet on the ground with a small gap between the two feet stance. The tree pose induces a greater instability as the subject is instructed to stand on one foot. As a result, it is difficult for the subject to stand still.

As discussed in the introduction earlier, to understand how the body works as in inverted pendulum, understanding how the human body controls the simultaneous movements of CoG and the center of pressure (CoP) are necessary. Figure 2 represents the body movements in the M/L direction in 6 distinguishable steps as follows:

At time 1, the body’s CoG is ahead and to the left of CoP with angular velocity (ω) that is assumed to be clockwise at that instant. Body weight (W) is equal and opposite to the ground reaction force (R), and these parallel forces...
act at distances $g$ and $p$, respectively, from the ankle joint. Considering the body to be an inverted pendulum pivoted about the ankle, an anticlockwise moment equal to $R_p$ and a clockwise moment equal to $W_g$ will be acting as $g > p$, then $W_g > W_p$, the body will experience a clockwise angular acceleration ($\alpha$). To correct the sway which is toward the right, at time 2, the participant will increase inverter activation to correct the angular velocity toward the left. Here, the CoG will move laterally toward the left. When the CoG is out of the area of the foot that makes contact with the ground, the hip abductor/adductor activation also increases in synchronous with the ankle inverter activation. At time 3, as the direction of the CoG has been reversed, the body will sway toward the left. The motion is controlled by both the ankle inverter/evertor movements and the hip abductor/adductor activation. This continues until the CoG is completely toward the left side of the foot. At time 4, the CNS senses the opposite shift as a result of which the ankle evertor is activated. As the CoG is now once again, outside the area of the foot that makes contact with the ground, the hip abductor/adductor is activated to stop the body from falling hence, swaying the CoG to the right. At time 5, the body sways to the left as a corrective measure to maintain stability until time 6. This is controlled by the hip and ankle activation. At time 6, the process repeats.

**MATERIALS AND METHODS**

With prior permission from the participants under study, analysis was made on ten different participants including both males and females (average age: 39.9 years, average weight: 64.5 kg, and average height: 168.2 cm). None of the participant had any neuromuscular impairment. The participants stood bare foot in the position to get comfortable and were instructed to stand as still as possible with eyes open. Four IMUs from X-IO Technologies were used to observe kinematic accelerations of superior fibers of the trapezius muscle, lower thoracolumbar fascia, vastus lateralis, and lateral gastrocnemius muscles as shown in Figure 3. These were fixed with low elastic rubber bands and then further reinforced by tape so as to avoid erroneous contributions to accelerations due to slippage. Data from these IMUs were recorded over a period of 30 s for three distinguished trials with a minimum of 1 min pause for the participant to relax. The data recorded was at a rate of 128 Hz. Signal noise (accelerations only) was reduced by using a low pass Butterworth filter of order $[N] = 6$ and cut-off ($f_c$) = 10 Hz. This was considered adequate as previous measurements of CoP that accompany body sway have shown that for young, healthy participants the principal power is contained in frequencies below 1 Hz while in some elderly participants the principal power is contained in frequencies between 1 and 3 Hz.$^{[11]}$ The raw data from the IMUs recorded the approximate rate at which the subject is changing his/her velocity in the M/L direction so as to maintain the specific posture at each instant. The IMUs provide the net acceleration along three axes of the device. Kinematic and gravitational components are a part of this acceleration. The separation of the kinematic and the gravitational components are performed as follows:$^{[12]}

- $g/B$, the vector representing the gravitational component can be expressed in sensor coordinate frame as follows:
  \[ g/B = [\sin\Theta - \cos\Theta]^T \]
  Where $\Theta$ and $(-\cos\Theta)$ are the gravitational components in the xb (dorsoventral axis) and zb (antero-posterior axis), respectively
- The values of $a_h$ (horizontal acceleration along U-axis) and $a_v$ (vertical acceleration along z-axis) are computed as follows:
  \[ a_h = -a_{sh} \cos\Theta - v_{sb} \sin\Theta \]
  \[ a_v = a_{sh} \sin\Theta - v_{sb} \cos\Theta + 1 \]
Where, \(a_{xb}\) and \(a_{zb}\) are the sensor reading along the \(x_b\) and \(z_b\) axes, respectively.

- In order to find the kinematic accelerations,
  \[a_{xb} = (a_h \cos \Theta) - (a_v \sin \Theta),\]
  \[a_{zb} = (a_h \cos \Theta) + (a_v \sin \Theta),\]
  \(a_{xb}\) being the kinematic component along \(x_b\) and \(a_{zb}\) being the kinematic component along \(z_b\).

To understand the role of the hip and ankle in maintaining body’s stance the variance for the three trials was computed. For example, the \(\sigma^2_{\text{hip}}\) and/or \(\sigma^2_{\text{ankle}}\) (over the interval of 30 s) suggest the corresponding use of the hip or ankle strategy so as to regain stability.

Cross-correlation is used for referring to correlations between the entries of two random vectors \(X\) and \(Y\) that always results in values ranging from \(-1\) to \(+1\) due to standardizing factor. Cross-correlations of the signals from the ankle and the hip were used to bring out the minute nuances of the role of hip and/or ankle strategies that come into play.

\[
(f \times g)[\tau] = \int_{-\infty}^{\infty} f(t)g(t+\tau)dt, \tag{1}
\]

Where \(f\) and \(g\) are continuous functions of time \(t\) and \(f^*\) denotes the complex conjugate of \(f\) and \(\tau\) is the time lag. The measure of similarities of the changes in accelerations at the hip \((a)\) and the ankle \((a)\) is quantified by cross-correlation between these signals (Equation 2). These cross-correlations are used to quantify resemblance in shape \((R^2 = 1)\) or complete divergation between two waveforms.\(^{13}\) Even complete nullification when they are completely out of phase will generate an \(R^2 = -1\).

\[
R_{ha}(\tau) = \frac{1}{T} \int_0^T R_{\text{frontal}}(t) \times R_{\text{ankle}}(t+\tau)dt \tag{2}
\]

\(R_{ha}(\tau)\) is the cross-correlation of \(R_h(t)\) and \(R_a(t)\) with a phase shift of \(\tau\). We set \(\tau = 0\) and normalize to contain cross-correlation between \(-1\) and \(1\). A high cross-correlation means the two variables, accelerations due to hip \((R_h)\) and accelerations due to ankle \((R_a)\) are acting in phase hence contributing in maintaining stability. However, a high negative correlation represents they are opposing, hence reducing stability. Correlations that are proximal to zero are interpreted as signals that are independent of each other. In order to cross correlate \(R_h(t)\) with \(R_a(t)\) over time \(T\), Equation 3 was used.

\[
R_{ha}(0) = \frac{1}{T} \int_0^T R_{\text{frontal}}(t) \times R_{\text{ankle}}(t) \sqrt{R_{hh}(0) \times R_{aa}(0)} dt \tag{3}
\]

Figures 4 and 5 demonstrate the accelerations in the left and right dominant foot while performing the asana.

Figure 4 demonstrates the accelerations from 20 s to 30 s while Figure 5 demonstrates the accelerations from 15 s to
25 s. These two readings were observed over a period of 30 s. As noticed in the Figures 4 and 5, the accelerations observed both at the hip and at the ankle are in sync with each other. Furthermore, the accelerations of the ankle are found to vary more than that of the hip indicating that the projection of CoG as shown in Figure 1 lies within the area of the feet and that small variations of the ankle joints (ankle strategy) are enough to maintain the body under balance. At situations where the body sways out of balance, that is, the accelerations of the CoG peaks (at time interval 25.5 s [Figure 4] and at time interval 17.8 s [Figure 5]), it is observed that the accelerations of the hip increases thus reinforcing our hypothesis that the hip strategy dominates the ankle strategy in regaining posture. However in all other cases, the hip strategy supports the ankle.

RESULTS AND DISCUSSION

Figure 6 shows a comparison of variances of neck, CoG, thigh, and ankle among 10 participants.

The cross-correlations between the hip and the ankle in three distinguished trials across both legs have been represented in Tables 1-3. Column “X” represents the correlation strategy that has been observed at the time instant, “t” when the CoG sees maximum disturbance across the entire interval of 30 s. As seen from Table 1, the correlations between the hip and the ankle in most of the trials are very high (~0.5 to ~1.0) irrespective of which leg the asana was performed on (for example: Subject 1, Subject number 3, Subject number 4, etc.). However, there are a few participants who have exhibited a slightly lesser correlation (~0.1 to ~0.5). As observed from Table 1, we can see that Subject number 3 has a very low correlation compared to the others. On juxtaposing this information with graphs seen in Figure 7, we observe that the hip strategy is independent of the ankle strategy as a result of a flat response of the hip when compared to the ankle. This demonstrates that Subject number 3 has performed the asana with greater sense of stability by virtue of maintaining the body’s CoG in equilibrium only with the use of the ankle strategy.

The role of the hip abductor/adductor in the M/L direction is evident from Table 1. Although there might not be one conclusion from Table 1, the inference solely depends on
Table 1: Cross-correlations between hip and ankle for trial 1

| Participant   | Left leg              | Right leg             |
|---------------|-----------------------|-----------------------|
| Trial 1       | Cross-correlation X   | Cross-correlation X   |
| Subject number 1 | 0.901 Hip             | 0.9029 Ankle          |
| Subject number 2 | 0.9992 Hip            | 0.953 Ankle           |
| Subject number 3 | 0.1748 Ankle          | 0.1854 Hip            |
| Subject number 4 | 0.7568 Ankle          | 0.5731 Hip            |
| Subject number 5 | 0.9093 Ankle          | 0.8582 Hip            |
| Subject number 6 | 0.7079 Hip            | 0.6659 Hip            |
| Subject number 7 | 0.8915 Hip            | 0.8915 Ankle          |
| Subject number 8 | 0.8557 Ankle          | 0.8294 Ankle          |
| Subject number 9 | 0.9273 Ankle          | 0.777 Ankle           |
| Subject number 10| 0.547 Hip             | 0.5615 Hip            |

Table 2: Cross-correlations between hip and ankle for trial 2

| Participant   | Left leg              | Right leg             |
|---------------|-----------------------|-----------------------|
| Trial 2       | Cross-correlation X   | Cross-correlation X   |
| Subject number 1 | 0.8857 Ankle          | 0.9270 Ankle          |
| Subject number 2 | 0.8638 Hip            | 0.6452 Ankle          |
| Subject number 3 | 0.1479 Ankle          | 0.1557 Ankle          |
| Subject number 4 | 0.8228 Ankle          | 0.7958 Ankle          |
| Subject number 5 | 0.9086 Ankle          | 0.6306 Hip            |
| Subject number 6 | 0.7545 Ankle          | 0.6659 Hip            |
| Subject number 7 | 0.8567 Ankle          | 0.6990 Ankle          |
| Subject number 8 | 0.7936 Ankle          | 0.8246 Ankle          |
| Subject number 9 | 0.8166 Ankle          | 0.8211 Ankle          |
| Subject number 10| 0.5253 Ankle          | 0.5456 Ankle          |

Table 3: Cross-correlations between hip and ankle for trial 3

| Participant   | Left leg              | Right leg             |
|---------------|-----------------------|-----------------------|
| Trial 3       | Cross-correlation X   | Cross-correlation X   |
| Subject number 1 | 0.8503 Ankle          | 0.9029 Ankle          |
| Subject number 2 | 0.8496 Hip            | 0.5553 Ankle          |
| Subject number 3 | 0.1706 Ankle          | 0.1746 Ankle          |
| Subject number 4 | 0.7869 Ankle          | 0.5294 Ankle          |
| Subject number 5 | 0.9081 Ankle          | 0.8582 Hip            |
| Subject number 6 | 0.5873 Ankle          | 0.5303 Ankle          |
| Subject number 7 | 0.8915 Ankle          | 0.7150 Ankle          |
| Subject number 8 | 0.8557 Ankle          | 0.8493 Ankle          |
| Subject number 9 | 0.9273 Ankle          | 0.7770 Ankle          |
| Subject number 10| 0.5578 Ankle          | 0.7227 Ankle          |

To gain better insights regarding the role of hip and ankle strategy and when they aid the person in regaining stability, column X in Table 1 helps us understand the same. This was deduced on the basis of the accelerations recorded at the hip, ankle, and the CoG. For example, at the instant where CoG peaks, the accelerations of the ankle and the hip are compared, and correspondingly, two cases arise: (a) If the acceleration of the ankle was greater than that of the hip, the conclusion drawn was that the ankle had a greater influence in regaining stability; (b) if the acceleration of the hip was greater than that of the ankle, the conclusion drawn was that the hip had a greater influence in regaining stability. It is imperative to realize that these accelerations are a true identity of the ardor in which the subject has performed the asana. It is necessary to know that participant with very low correlations show that the body can be balanced only by activating the ankle joints in order to maintain proper stance with minimum amount of sway. However, if the body sway supersedes the control of the ankle joints, the hip get activated as a corrective measure to regain stable stance as proved in certain cases described in Table 4.

CONCLUSION

In agreement of our original hypotheses, we were correct in establishing an accord with the role of the hip and ankle strategy and the instances they come to picture while maintaining stability while performing Vrikshasana. The intricacy of the combination of control mechanisms was not simple, yet we have proved the initially stated hypothesis.

Contributions of the hip abductor/adductor mechanism were hypothesized to be seen only when the body tipped excessively out of balance while performing the asana. In all other cases, the ankle invertor/evertor support the human body’s stability. The correlations shed light on the effect of these two strategies in maintaining balance, and as seen in most cases, the hip always supported the ankle in maintaining stability, but never was the effect of one over the other was of subtractive nature.

These findings demonstrate that the balance and control of the human body while performing Vrikshasana. Balance and control is not a simple single motor control pattern but is a collaborative effort between two or more independent motor mechanisms. The significance of understanding the combined effort of these motor groups finds its importance in evaluating the balance control in many populations of people: Knee-replacement patients, full or partial leg amputees, stroke patients who have lost one-sided control of both ankle and hip muscles etc. In these conditions, we could identify the muscle groups that is influencing the increased changes in CoP. The cerebellum could serve to relate these separate motor strategies because lesions
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of the vermis and intermediate regions cause ataxia.\textsuperscript{[14,15]} Cerebellar patients fail to scale properly the duration and magnitude of muscle responses to maintain upright stance.\textsuperscript{[14]} Thus, neural disorders in the cerebellum would be predicted to exhibit major conflicts between these two mechanisms. The role of these balance mechanisms is also important in study falls in the elderly. Ultimately, these bio-mechanical insights provide evidence that may be used by instructors, clinicians, and therapists when selecting pose modification for their yoga participants.

\textbf{Declaration of patient consent}

The authors certify that they have obtained all appropriate patient consent forms. In the form the patient(s) has/have given his/her/their consent for his/her/their images and other clinical information to be reported in the journal. The patients understand that their names and initials will not be published and due efforts will be made to conceal their identity, but anonymity cannot be guaranteed.

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\textbf{Conflicts of interest}

There are no conflicts of interest.

\textbf{REFERENCES}

1. Bijilani RL. Understanding Medical Physiology, A Text Book for Medical Students. 3\textsuperscript{rd}ed. New Delhi: Jaypee Brothers Medical Publishers; 1995. p. 882-95.
2. Gopal KS, Anantharaman V, Balachander S, Nishith SD. The cardiorespiratory adjustments in ‘Pranayama’, with and without ‘Bandhas’, in ‘Vajrasana’. Indian J Med Sci 1973;27:686-92.
3. Allhoff F, Swan LS, editors. Yoga – Philosophy for Everyone: Bending Mind and Body. Sussex, UK: Wiley; 2012.
4. Nashner LM, McCollum G. The organization of human postural movements: A formal basis and experimental synthesis. Behav Brain Sci 1985;8:135-72.
5. Gatev P, Thomas S, Kepple T, Hallett M. Feedforward ankle strategy of balance during quiet stance in adults. J Physiol 1999;514:915-28.
6. McCollum G, Leen TK. Form and exploration of mechanical stability limits in erect stance. J Mot Behav 1989;21:225-44.
7. Dietz V, Berger W. Spinal coordination of bilateral leg muscle activity during

\begin{table}[h]
\centering
\begin{tabular}{|c|c|c|c|c|c|}
\hline
\textbf{Subject} & \textbf{Original} & \textbf{Trial-1} & \textbf{Trial-2} & \textbf{Trial-3} \\
\hline
& \textbf{Left leg} & \textbf{Right leg} & \textbf{Left leg} & \textbf{Right leg} & \textbf{Left leg} & \textbf{Right leg} \\
\hline
Subject number 1 & ✓ & ✓ & ✓ & ✓ & ✓ & ✓ \\
Subject number 2 & ✓ & ✓ & ✓ & ✓ & ✓ & ✓ \\
Subject number 3 & ✓ & ✓ & ✓ & ✓ & ✓ & ✓ \\
Subject number 4 & ✓ & ✓ & ✓ & ✓ & ✓ & ✓ \\
Subject number 5 & ✓ & ✓ & ✓ & ✓ & ✓ & ✓ \\
Subject number 6 & ✓ & ✓ & ✓ & ✓ & ✓ & ✓ \\
Subject number 7 & ✓ & ✓ & ✓ & ✓ & ✓ & ✓ \\
Subject number 8 & ✓ & ✓ & ✓ & ✓ & ✓ & ✓ \\
Subject number 9 & ✓ & ✓ & ✓ & ✓ & ✓ & ✓ \\
Subject number 10 & ✓ & ✓ & ✓ & ✓ & ✓ & ✓ \\
\hline
\end{tabular}
\caption{Variation of hip over ankle at peak control group}
\end{table}

\begin{figure}[h]
\centering
\includegraphics[width=\textwidth]{figure7}
\caption{(a and b) Subject number 3, trial-1 left leg and right leg, respectively. (c and d) Subject number 3, trial-2 left leg and right leg, respectively}
\end{figure}
8. Brunt D, Andersen JC, Huntsman B, Reinhert LB, Thorell AC, Sterling JC. Postural responses to lateral perturbation in healthy subjects and ankle sprain patients. Med Sci Sports Exerc 1992;24:171-6.

9. Yu SS, Wang MY, Samarawickrame S, Hashish R, Kazadi L, Greendale GA, et al. The physical demands of the tree (vrikasana) and one-leg balance (utthita hasta padangusthasana) poses performed by seniors: A biomechanical examination. Evid Based Complement Alternat Med 2012;2012:971896.

10. Winter DA, Prince F, Frank JS, Powell C, Zabjek KF. Unified theory regarding A/P and M/L balance in quiet stance. J Neurophysiol 1996;75:2334-43.

11. Lucy SD, Hayes KC. Postural sway profiles: Normal Subjects and subjects with cellular ataxia. Physiother Can 1985;37:1.

12. Omkar S, Mour M, Das D. Motion analysis of sun salutation using magnetometer and accelerometer. Int J Yoga 2009;2:62-8.

13. Bendat JS, Piersol AG. Random Data: Analysis and Measurement Procedures. 2nd ed. New York: John Wiley; 1986.

14. Horak FB, Diener HC. Cerebellar control of postural scaling and central set in stance. J Neurophysiol 1994;72:479-93.

15. Dichgans J, Fetter M. Compartmentalized cerebellar functions upon the stabilization of body posture. Rev Neurol (Paris) 1995;149:654-64.

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