Assessing Lower Extremity Injury Risk in a Mid-Atlantic Drum Corps Using the Weight Bearing Lunge Test

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ABSTRACT

With athletic training's expansion into non-traditional settings, it is important to assess if screening tools can provide value in range of settings. Currently, there is a dearth of information regarding specific models for injury risk assessment in drum corps patients. The Weight Bearing Lunge Test (WBLT) has been used to evaluate those at risk for suffering a lower extremity injury (LEI) in a traditional athletic population. This practice-based research is an attempt to apply current evidence of injury risk assessment use in the traditional settings to performing arts. The purpose of our investigation was to determine the effect of WBLT motion on LEI in Drum Corps. All participating Drum Corps members were measured using the WBLT during the preseason screening process. Injury record keeping was completed through electronic medical records (EMR) and all LEI were recorded over two consecutive, 85-day seasons. The average of the maximal distance in centimeters of the great toe from the wall indicated the WBLT Average (WBLTAv). WBLT Asymmetry (WBLTAsy) was the absolute difference between limbs. T-tests were used to determine if there was a significant difference between those who sustained a LEI (Injured) and those who did not (Uninjured) for WBLTAv and WBLTAsy. For dependent measures associated with significant group differences, receiver operator characteristic curves (ROC) were performed to examine injury risk using area under the curve (AUC). Lastly, cut-off scores that produced the maximal values of sensitivity and specificity were identified. Alpha level was set *a priori* at $p<0.05$. Drum Corps patients with lower WBLTAv (<11.47cm) or higher WBLTAsy (>0.75cm) measures were more likely to sustain a LEI during a competitive drum corps season. These data demonstrates that the WBLT could be viable as a screening tool in the marching arts and provides initial cut-off values.

Key Phrases
Injury risk reduction, injury surveillance, performing arts

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INTRODUCTION

A modern drum and bugle corps is a musical marching ensemble consisting of brass instruments, percussion instruments, synthesizers, and color guard. Drum and bugle corps are considered marching music's major league. These groups practice for over 10 hours a day, on their feet, and have high incidence of lower extremity injury (LEI). LEI is more common to occur in marching ensembles than injury to the upper extremity.[1] The most common injuries are medial tibial stress syndrome, achilles tendonitis, and ankle sprain. The commonality of these injuries in combination with their impact on heath and participation signifies the need to develop LEI preventative practices in this population to enhance patient safety.[1]

The first step to injury prevention is identifying those individuals that may be most at risk. In order to accomplish this, clinicians need efficient and effective screening tools. Screening tools usually examine range of motion, balance, strength, and/or other modifiable risk factors as potential injury risk predictors. There are many tools that may be effective in assessing injury risk in populations with high incidence of LEI.[2-6] Ankle dorsiflexion range of motion (DROM) is a simple measure that has a lot of supportive research in relation to LEI risk.[2-6] DROM has been used with basketball, volleyball, gymnastics, and other various sports and activities.[7] The weight bearing lunge test (WBLT), specifically, is a common quantification technique that measures DROM in a

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weight bearing position. Research has demonstrated that the WBLT can be used to quantify DROM and predict LEI.[7] Additionally, the WBLT has been associated with measures of dynamic movement[8] and balance[9] which have also been associated with injury risk in physically active populations.[10]

DFROM has been shown to have utility to predict individuals at risk of LEI in sports populations. This method, however, has not been conducted with the Drum Corps population. Therefore, the purpose of this study is to determine the effect of DROM on LEI risk within a Mid Atlantic Drum Corps by assessing DROM using the WBLT.

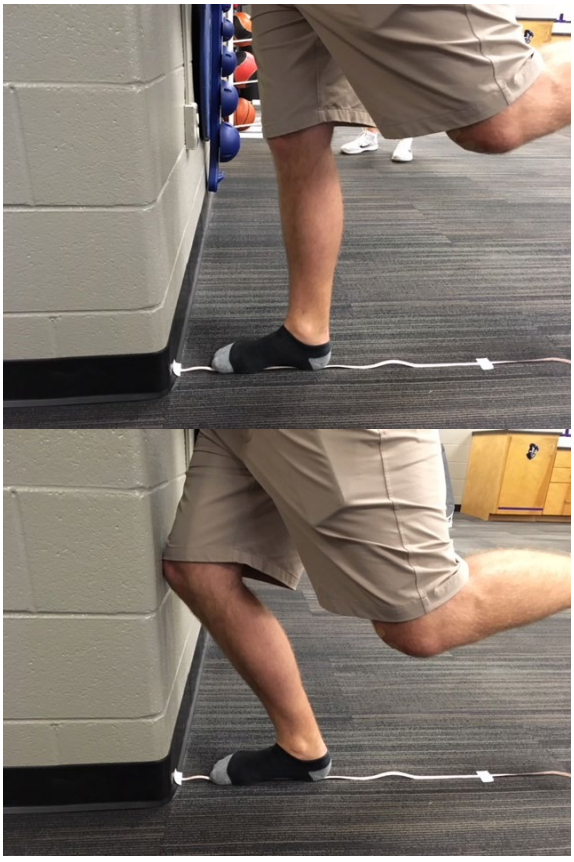
PATIENTS:

Two hundred thirty-eight patients from a Drum Corps International group from the Mid-Atlantic region that competes seasonally (Male=173, Female=65, Age=19.49± 1.05yrs) were screened as part of the pre-participation exam prior to the 2016 and 2017 seasons. Patients with current lower extremity injury at the time of data collection did not participate and were not included in the study. Patients who were included in this study were then monitored throughout the competitive season for lower extremity injury (LEI).

INTERVENTION:

The WBLT was used to measure weight bearing dorsiflexion ROM bilaterally in all patients. Assessment of the WBLT measurement in a systematic review suggested strong evidence that the inter-clinician reliability (ICC=0.80-0.99, MDC 4.6° or 1.6cm) and the intra-clinician reliability (ICC=0.65-0.99, MDC 4.7° or 1.9cm) were good.[11] The WBLT was performed using the knee-to-wall principle (Figure 1).[10,11] Patients were in a standing position facing a wall with the test foot parallel to and on top of a measuring tape. The measuring tape was secured to the floor with athletic tape or an equivalent. The second toe, heel, and knee of the test foot were perpendicular to the wall during the testing session. While maintaining a single leg stance, patients were instructed to perform a lunge towards the wall by flexing the knee while keeping the heel of the test foot firmly fixed to the testing surface and without letting the knee sway medially or laterally. The opposite limb of the test foot was allowed to be suspended in knee flexion and non-weight bearing while the test foot went through the proper motion. Patients were able to place their hands on the wall for balance if desired. The test foot was progressed away from the wall in one centimeter (cm) increments and repeated until the knee or heel of the test limb lost contact with the wall and/or floor respectively. The foot placement was then adjusted in smaller increments in order to have the foot the farthest point away from the wall while maintaining knee and heel contact and maximum lunge distance was recorded. The final successful trial was recorded for statistical analysis. WBLT measurements were completed by four individuals, two athletic trainers with 1-2

Figure 1. Weight Bearing Lunge Test (WBLT).



years of experience and two athletic training students.

OUTCOME MEASURES:

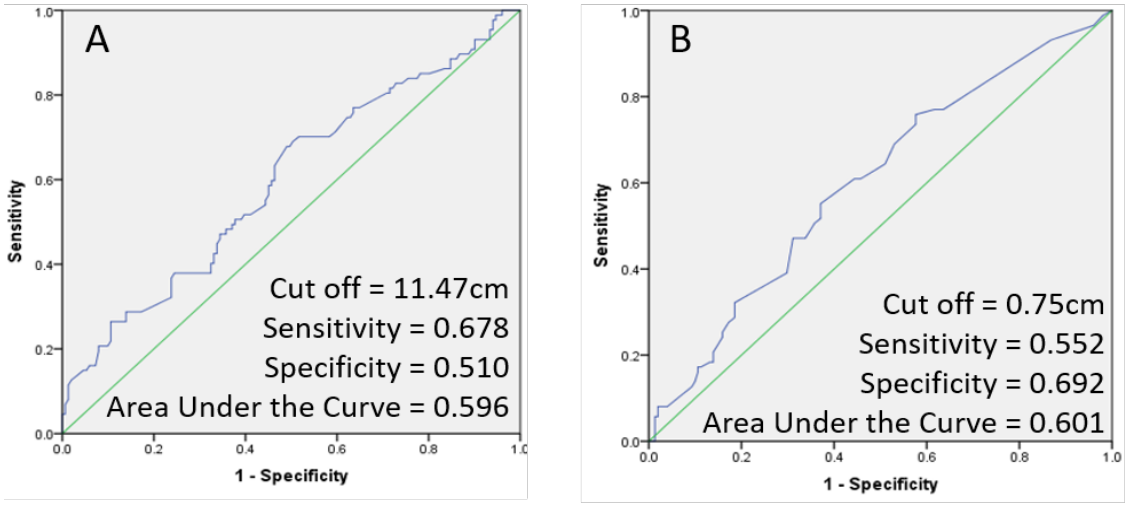
Injury electronic medical records were stored in a password protected, HIPAA compliant, online spreadsheet (G suite™ by Google©) and was used to keep track of the number of lower extremity injuries sustained over the two 85 day seasons. Each patient injury was recorded into the online spreadsheet; patients sustaining multiple injuries were included in the analysis for their first LEI only. The definition of a lower extremity injury was an injury that caused removal from activity and loss of practice time for a total of four or more cumulative hours (one practice block).

Analyses were completed using a statistical software program (IBM Corp. Released 2015. IBM SPSS Statistics for Windows, Version 23.0 Armonk, NY: IBM Corp). Means and standard deviations of WBLT, average, and asymmetry measures were calculated for injured and non-injured patients. The average of the maximal distance in centimeters of the great toe from the wall indicated the WBLT Average (WBLTAv). WBLT Asymmetry (WBLTAsy) was the absolute difference between limbs. T-tests were used to determine if there was a significant difference between those who sustained a LEI (Injured) and those who did not (Uninjured) for WBLTAv and WBLTAsy. For dependent measures associated with significant group differences, receiver operator characteristic curves (ROC) were performed to examine injury risk using area under the curve (AUC). Lastly, cut-off scores that produced the maximal values of sensitivity and specificity were identified. Alpha level was set a priori at $p<0.05$.

RESULTS:

LEI occurred in 87 of 238 patients during the 2016 and 2017 drum corps regular seasons (Table 1). The normalized WBLTAv and WBLTAsy for injured and uninjured patients are presented in Table 2. The injured WBLTAv was significantly less compared to the uninjured ($p=0.005$). The injured WBLTAsy was significantly greater compared to the uninjured ($p=0.015$). The AUC from the ROC analysis (Figure 2) for WBLTAv and WBLTAsy was 0.596 and 0.601 respectively. A WBLTAv cutoff score of 11.47cm was associated with a sensitivity of 0.678 and a specificity of 0.510. A WBLTAsy cutoff score of 0.75cm was associated sensitivity of 0.552 and a specificity of 0.629. This data demonstrates that if a drum corps individual has a WBLTAv measure less than 11.47cm, they are 40% more likely to sustain an LEI; if a drum corps individual has a WBLTAsy measure greater than 0.75cm, then they are 49% more likely to sustain an LEI (Figure 2).

Figure 2. Receiver Operator Curve: A) WBLT Average and B) WBLT Asymetry.



DISCUSSION:

The purpose of this study was to determine if a relationship exists between DROM and LEI risk in the drum corps population. Slightly over one-third of the patients sustained an LEI during the 170 days of participation. This study demonstrate that individuals with greater measures of average weight bearing DROM (WBLTAv > 11.47cm) are less likely to become injured and individuals with a greater asymmetry of weight bearing DROM (WBLTAsy > 0.75cm) between limbs are more likely to become injured. These findings are the stepping stone to say that weight bearing DROM may be a predictor of injury in the drum corps population.

The results of this practice-based research identified WBLTAv ($p=0.005$) and WBLTAsy ($p=0.015$) differences between those that sustained a LEI and those that did not. To further analyze the utility of the WBLT, cutoff scores were calculated. While our findings indicated relatively low predictive accuracy overall, as signified by moderate AUC values (0.596 and 0.601), each measure fared well at either ruling in or out injury. This was indicated by WBLTAv sensitivity and WBLTAsy specificity values of almost 0.70. In terms of positive and negative likelihood ratios, this indicates that a drum corps member who have less than a 11.47cm WBLTAv are about 40% more likely to sustain a LEI than a member over that value (LR+ = 1.38). Additionally, if a member has greater than 0.75cm WBLTAsy, then they are 49% more likely to sustain a LEI than an individual with less asymmetry.

Overall, the results of this study indicate that the WBLT is a feasible screening method that does demonstrate useful data for a clinician to determine a drum corps member's LEI risk. These findings are similar to previous literature on LEI risk in traditional athletic populations.[2-6] Furthermore, due to DROM's nature as a modifiable risk factor, injury prevention programs could be implemented to reduce an individual's risk of LEI. We propose that this method of screening can be completed prior to the season, and could allow clinicians to identify at risk individuals and ultimately decrease the overall frequency of LEI for the season once these individuals have modified their weight bearing DROM through prevention programs. At this time however, there is a need to evaluate the best practices for increasing DROM in a prophylactic manner.

We experienced a number of obstacles during the implementation of the WBLT, however, we determined how to overcome these obstacles in the future. The implementation of the WBLT screening with multiple individuals in a short time span could have resulted in possible error. The WBLT takes approximately thirty seconds to one minute to perform with one patient. Therefore, it is suggested for future studies to either increase the number of trained individuals administering the screening, or increase the amount of time available to complete the screening with the drum corps Members. An athletic training student was trained and completed practice sessions, but since the WBLT was a new procedure for the athletic training student, this inexperience may have compromised the ability to record accurate measurements. In order to reduce error, it is recommended that individuals who are properly trained and who have previous experience should administer the screening. The number of participants participating in the study may have been too low to provide accurate data for analysis. Additional participants may be needed in future studies. This can be accomplished by introducing multiple drum corps groups to the screening and conducting data on all the groups combined, not just one corps for two seasons. Additionally, the definition of LEI included any injury distal to the hip. Although DROM can be associated with injuries proximal to the ankle, it is not the only correlating factor. These factors may have produced inaccurate measurements causing a misrepresentation of the studied population. Additional research in this area could explore other modifiable risk factors such as knee and hip posture/range of motion, as well as factors such as sex and instrument type, as these could play a contributing role to injury risk within Drum Corps.

CLINICAL IMPLICATIONS:

Little research has been conducted regarding injury prevalence and injury risk factors within the performing arts athlete population, specifically drum corps. Our study provides an initial look into potential risk factors for LEI. Clinicians could utilize this data and the WBLT within the drum corps population to screen for LEI risk and identify individuals with higher risk of LEI. Cutoff scores of greater than 0.75cm WBLTAsy and less than 10.40cm WBLTAv should be used to identify drum corps members that may be at greater risk of sustaining a LEI. With this information, healthcare providers can identify at-risk individuals and prescribe preventative measures in order to mitigate the potential injury during the drum corps season. In conclusion, our research study provides a starting point for prevention research in this unique population. However, additional research studies are needed regarding risk factors that predispose performing arts athletes to injury. Such studies can indicate how to best provide prevention strategies for the performing arts athletes in order to increase health related quality of life.

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