Ipsilateral Tibiotalar Joint Osteoarthritis Transferred to the Contralateral Tibiotalar Joint

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abstract

Classically, it has been thought that pain or disability in one leg can stress the contralateral leg, leading to similar symptoms. The mechanism of action for subsequent dysfunction in the healthy limb is thought to involve compensatory changes that are used as a means to reduce stance phase time on the injured limb. This is believed to increase the forces distributed across the healthy limb, ultimately leading to injury. This belief has been challenged, as supportive literature is sparse. The goal of this study was to determine whether an association between tibiotalar (TT) osteoarthritis (OA) in the right vs left lower extremity exists, and whether injury to one lower extremity leads to degeneration in the contralateral lower extremity. The authors evaluated 704 TT joints to determine the presence of OA. A multiple linear regression was performed using a standard P value cutoff (P<.05) and 95% confidence interval. The absolute value of the difference between right and left TT OA was compared for specimens in each decade of life. Multiple regression analysis revealed a positive correlation between right and left TT OA, after correcting for age, sex, and race. Right TT vs left TT had a slope of 0.489 with a P value approaching 0. Findings indicated the absolute value of the difference between right and left TT OA was not zero, and this difference remains significant throughout life. Based on these findings, OA in one ankle does not appear to lead to accelerated OA in the contralateral ankle. [Orthopedics. 2016; 39(4):e664-e667.]

Classically, it is thought that pain or disability in one lower extremity can cause injury to the contralateral, healthy limb. The mechanism of action for subsequent dysfunction in the healthy limb is thought to involve compensatory changes that are used as a means to reduce stance phase time on the injured limb. This is believed to increase the forces distributed across the healthy limb, ultimately leading to injury.

This theory has been supported by studies that have investigated load distributions and joint changes of the retained limb in amputee patients. In a 1954 study, Eberhart et al found that the natural leg carries more load than the prosthetic leg and that more time is spent on the natural leg during gait. This provided the basis for Borgmann’s 1960 study that described the development of osteoarthritis (OA) in the hips and knees of the natural limb in amputee patients. In a 1975 study, Hungerford and Cockin found a significant increase in tibiofemoral and patellofemoral OA in the natural limb of amputees. Burke et al investigated
joint changes in lower-limb amputees in 1978 and found an increase in knee OA of the natural leg. Recently, Kraus et al.\(^5\) found a high prevalence of contralateral radiographic tibiotalar (TT) ankle OA in patients with knee OA and malalignment, and concluded that a kinematic association may exist.

In 1994, Harrington and Harris\(^6\) questioned whether disability in one leg could stress the other and produce symptoms. They concluded there was an absence of “hard data” in support of the belief that favoring one leg adversely affects the contralateral leg and that any possible effects related to alterations in gait would likely take many years to arise. In 2005, Harrington\(^7\) expanded on his previous findings to conclude that there was no clear evidence to suggest an injury to one lower extremity significantly impacts the opposite uninjured limb, unless the injury resulted in major muscle and nerve damage, or a limb-length discrepancy greater than 4 cm was present. Furthermore, Harrington\(^7\) stated that temporary gait abnormalities and use of an assistive implement were unlikely to adversely affect the uninjured limb.

There are limited data in support of the belief that injury to one leg can cause subsequent dysfunction in the other leg, and more recently, this idea has been questioned. Therefore, the goal of this study was to identify whether there is an association between TT joint OA in the right vs left lower extremity, and to determine whether injury to one TT joint leads to degeneration across the contralateral TT joint.

**Materials and Methods**

The Hamann-Todd Human Osteological Collection at the Cleveland Museum of Natural History (Figure 1) contains more than 3300 treated and dried specimens from bodies that were collected from the county morgue and city hospitals from 1893 to 1938. A single examiner evaluated 704 TT joints (Figure 2) using a modification of the Kellgren-Lawrence Classification for Knee Osteoarthritis\(^8\) to determine the presence of OA in each specimen (Table 1). The 4-point grading scale was modeled after Videman et al.\(^9\) This scale was based on methods suggested by Kettler and Wilke\(^10\) and previously validated by Eubanks et al.\(^11\) Bony endplate changes and facet arthrosis were used to grade disk degeneration at the L5-S1 interspace. Grades were assigned based on the corresponding criteria:

- **Grade 0**: normal facet joints or vertebral end plates.  
- **Grade 1**: mild arthrosis with osteoarthritic reaction involving up to 50% of the facet joint or vertebral end plates.
- **Grade 2**: moderate arthrosis with osteoarthritic reaction involving anywhere from 50% to 100% of the facet joint or vertebral end plates.
- **Grade 3**: severe arthrosis with an osteoarthritic reaction involving 100% of the facet joints or vertebral end plates with hypertrophic osteophytes bridging the joint space.
- **Grade 4**: complete ankylosis.

A statistical analysis of the compiled data was performed using Statgraphics software (Statpoint Technologies Inc, Warrenton, Virginia). A multiple linear regression was performed comparing right TT OA vs left TT OA and correct-
ing for confounding factors (ie, age, sex, and race) using a standard $P$ value cutoff ($P<.05$) and 95% confidence interval to determine statistical significance.

The absolute value of the difference between right and left TT OA then was compared for specimens from individuals who were younger than age 20; specimens from individuals who were in the fourth, fifth, sixth, seventh, and eighth decade of life; and finally, for specimens from individuals who were older than 80 years.

### RESULTS

The multiple regression analysis revealed a positive correlation between right and left TT OA after correcting for age, sex, and race. Right vs left TT had a slope of 0.489 with a $P$ value approaching 0, indicating a positive correlation between right and left TT OA (Table 2 and Figure 3). One variable analysis also was conducted for the absolute value of the difference of right and left TT OA for various decades of life (Table 3).

### DISCUSSION

The classic theory suggests that injury to one lower extremity can subsequently cause dysfunction in the contralateral lower extremity. This theory has been widely popularized in the personal injury and workers’ compensation populations, but more recently, the theory has been doubted. Due to the limited evidence in support of this model, the current study sought to investigate any relation between right and left TT OA, and also to determine whether arthritic changes in one ankle lead to advanced degeneration in the other. The hypothesis was that if TT OA in one ankle leads to TT OA in the contralateral ankle, then a decreasing pattern would be observed in the sample mean as time increased.

To explore this hypothesis, a retrospective, cadaveric study was performed. This analysis contained benefits and limitations inherent to the study design. It was inexpensive and could be executed quickly. However, specimen availability limited the sample size, and the attainment of subjective information was not possible. A prospective cohort where patients could undergo follow-up with imaging, physical examination, surveys, and autopsy would be the optimal study design, but such studies would take many years and would be expensive.

The first finding of the current study was that right TT joint OA was significantly associated with left TT joint OA after correcting for age, sex, and race. The next question that was investigated

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### Table 2

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Estimate</th>
<th>Error</th>
<th>Statistic</th>
<th>$P$</th>
<th>Sum of Squares</th>
<th>$df$</th>
<th>Mean Square</th>
<th>$F$ Ratio</th>
<th>$P$</th>
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<tbody>
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<td>Constant</td>
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<td>0.112574</td>
<td>4.02526</td>
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</table>

**Abbreviation:** TT, tibiotalar.

*aCorrected for age, sex, and race.

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### Table 3

<table>
<thead>
<tr>
<th>Age Group, y</th>
<th>Sample Mean</th>
<th>$P$</th>
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<tr>
<td>&lt;20</td>
<td>0.571</td>
<td>.03</td>
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<td>20-29</td>
<td>0.592</td>
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<td>30-39</td>
<td>0.625</td>
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<td>40-49</td>
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<td>50-59</td>
<td>0.627</td>
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<td>60-69</td>
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<td>70-79</td>
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</tr>
<tr>
<td>&gt;80</td>
<td>0.478</td>
<td>Approaching 0</td>
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</table>

**Abbreviation:** TT, tibiotalar.
was whether arthritic changes in one ankle led to degeneration across the contralateral ankle. If degeneration in one ankle led to degeneration in the contralateral ankle, it was expected that the absolute value of the difference between right and left TT joint OA would be higher at a younger age and then ultimately would begin to even out as age increased. However, variable analyses of the absolute value of right TT OA minus left TT OA in each age group examined did not reveal a decreasing sample mean as age increased. Rather, the sample mean remained relatively stable earlier in life and eventually began to increase later in life.

Therefore, these findings indicate that degeneration about one ankle does not seem to lead to degeneration about the contralateral ankle. These degenerative changes appeared to occur at the same rate in both sides, explaining why the difference of the absolute value of right TT OA minus left TT OA remains relatively constant with increasing decades of age.

A strong history is necessary to diagnose symptoms that arise in the contralateral, uninjured leg. The findings in this study may help eliminate a mechanism of injury previously ranked high on the differential in such cases. In addition, this knowledge can provide specialists with further insights into caring for unilateral TT OA. Treatment options can possibly be focused on the impaired ankle without having to be concerned about forces generated in the contralateral ankle.

**CONCLUSION**

The literature review revealed that although a popular notion, the literature supporting the belief that dysfunction in one leg can cause subsequent dysfunction in the other was sparse. More recently, this idea has been questioned.

The data analysis in this study revealed that there was indeed a strong correlation between right and left TT OA after correcting for sex, race, and age. In addition, variable analyses of the absolute value of right TT OA minus left TT OA in each age group did not reveal a decreasing sample mean as age increased. In contrast, the sample mean remained relatively stable earlier in life and eventually began to increase later in life. Thus, these findings indicate that although right and left TT OA are strongly correlated, the rate at which each ankle degenerates remains relatively stable throughout decades.

The findings of this study can help narrow the differential in patients who present with symptoms in the uninjured limb. Finally, these findings can provide specialists with further insights when dealing with this type of injury.

**REFERENCES**