Watson-Jones tenodesis for ankle instability

A mechanical analysis in amputation specimens

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The stabilizing effect of a modified Watson-Jones ankle tenodesis was studied in 10 lower extremity amputation specimens using a kinesiologic testing device. Cutting of the lateral ligaments caused maximal instability in adduction of the entire hindfoot joint complex, as well as of the talocalcaneal joint. The tenodesis restricted adduction and internal rotation when compared with the movement pattern with intact ligaments. Instability in external rotation persisted because the tenodesis did not restore the function of the calcaneofibular ligament.

Our study confirms clinical observations that the Watson-Jones ankle tenodesis prevents abnormal inversion of the hindfoot, but does not restore hindfoot kinematics.

We have analyzed the stabilizing effect of the Watson-Jones ankle tenodesis on hindfoot joint movements following a defined injury to the lateral ligaments.

Materials and methods

Ten osteoligamentous cadaveric lower extremity specimens obtained after amputations for malignant tumor, thromboembolism, or arterial disease were studied. Only specimens macroscopically normal from 20 cm above the ankle level and distally were used. All the specimens were frozen to –25 °C immediately after amputation. After thawing, the skin, subcutaneous tissue, muscles and tendons traversing the ankle and talocalcaneal joint were removed, preserving only the ligamentous structures and the lesser peroneal tendon. The superior peroneal retinaculum was removed, whereas the inferior peroneal retinaculum was preserved. Specimens with elongated, scarred, or no ligamentous structures in the hindfoot, and specimens with arthrosis of the ankle or talocalcaneal joint were discarded. During the testing procedure, all the specimens were kept moist.

A modified Watson-Jones ankle tenodesis was performed using the lesser peroneal tendon (Lucht et al. 1981). The tendon was left intact on the fifth metatarsal bone and was passed through a 6.5-mm horizontal drill hole in the fibula from behind 4 cm above the malleolar tip (Figure 1). Further, the tendon was passed from above through a 5-mm drill hole in the lateral part of the neck of the talus to end in the upper part of the sinus tarsi. Finally, the tendon was passed back through the hole in the fibula and sutured to itself. The tenodesis was performed with the hindfoot in the neutral position and with 1-kg tension on the tendon. To imitate the stabilizing effect of the superior peroneal retinaculum, the tendon was finally sutured to the periosteum on the posterior surface of the lateral malleolus.

Our experimental set-up, the testing device, the testing procedure, computation of recorded movements, and reproducibility of measurements were described by Nielsen et al. (1985) and Kjærsgaard-Andersen et al. (1987a, b, 1988). The torque and moment used in the present study was 1.5 Nm. Because the standard lever arm from the strain gauges to the center of the measured joints was 15 cm, the resulting force submitted to the joints was approximately 10 N. Moreover, the distance from the center of the joints to the lateral ligaments averaged 3 cm, whereby the force applied to the ligaments was approximately 50 N.

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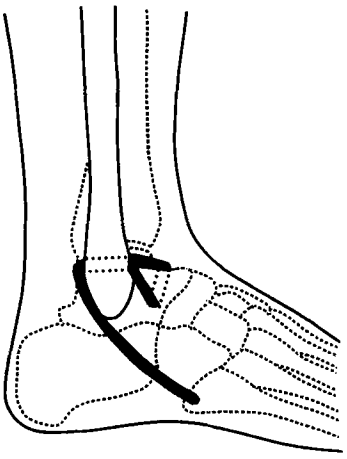

Figure 1. The modified Watson-Jones ankle tenodesis.

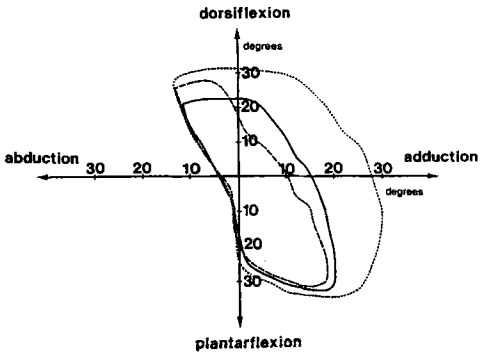

Figure 2. Two-plane movement curves for the hindfoot joint complex, ——— intact ligaments, ·····cutting of the anterior talofibular ligament, and the calcaneofibular ligament, ------modified Watson-Jones ankle tenodesis.

Table 1. Median movements (degrees) in the hindfoot joint complex (I) and the talocalcaneal joint (II) in 10 specimens measured in the neutral joint position for the corresponding plane (see text for explanation). A, intact ligaments; B, the calcaneofibular ligament and the anterior talocalcaneal ligament sectioned; C, modified Watson-Jones ankle tenodesis. Lower and upper quartiles are given in brackets

	A		B		C	
Movement	I	II	I	II	I	II
Adduction	15 (12–16)	9 (8–12)	30^{***} (28–30)	14^{***} (11–15)	12^{*} (10–15)	8^{**} (6–9)
Abduction	8 (7–9)	5 (3–5)	8^{-} (7–9)	5^{-} (3–6)	8^{-} (7–9)	4^{-} (3–6)
Internal rotation	20 (19–23)	9 (8–13)	34^{***} (29–38)	11^{**} (9–13)	12^{***} (12–18)	7^{***} (5–7)
External rotation	12 (8–14)	5 (4–7)	15^{***} (11–17)	7^{**} (6–8)	15^{*} (10–17)	7^{**} (6–8)
Plantar flexion	26 (15–32)	5 (3–6)	28^{***} (22–37)	5^{-} (4–6)	25^{*} (17–29)	3^{-} (2–3)
Dorsiflexion	26 (22–29)	2 (1–3)	32^{***} (29–37)	3^{**} (2–5)	27^{-} (23–35)	3^{**} (2–5)

$^{-}$not significant, $^{*}P < 0.05$, $^{**}P < 0.02$, $^{***}P < 0.01$.

The testing device measured movements in three planes. Continuous recordings for abduction-adduction and internal-external rotation, respectively, were obtained during plantar-dorsiflexion movements. All the specimens were sequentially tested. During the tests, no sliding was observed of the lesser peroneal tendon in the drill holes.

a) Movements in the hindfoot joint complex were recorded.

b) The ankle joint was kept in neutral position by external fixation; two pins through the distal tibia and two through the proximal talus were joined by crossbars. The mobility of the talocalcaneal joint was recorded.

c) The anterior talofibular ligament and the calcaneofibular ligament were cut, and mobility of the talocalcaneal joint was recorded.

d) The tenodesis was performed, and mobility in the talocalcaneal joint was recorded.

e) The ankle joint fixation was abolished, and mobility in the hindfoot joint complex, with injury to the ligaments and with the tenodesis, was recorded.

f) Finally, the tenodesis was abolished, and mobility in the hindfoot joint complex with cut ligaments was recorded.

Nonparametric statistics was applied (Pratt's matched-pair signed-rank test). Data are presented by the median and the upper and lower quartiles.

Results

All the specimens showed the same instability pattern following lesion to the ligaments and for the stabilizing effect of the tenodesis (Figure 2).

Hindfoot joint complex. Cutting of both lateral ligaments resulted in marked instability for all the movements apart from abduction. The instability was largest in adduction and internal rotation (Table 1). Following the tenodesis, all the specimens had reduced adduction and internal rotation compared with movements with intact ligaments. This was a constant observation during the entire range of plantar-dorsiflexion. However, the instability in external rotation following a lesion to the ligaments was not influenced by the tenodesis.

Talocalcaneal joint. Movements in the talocalcaneal joint were minor compared with those in the hindfoot (Table 1). The types of instability following lesion to the ligaments were similar to those of the hindfoot, with greatest instability in adduction, external rotation, and dorsiflexion. Following the tenodesis, the largest reduction in movement, compared with that with intact ligaments, was recorded for internal rotation with only a minor limitation in adduction and no stabilizing effect on external rotation.

Discussion

The Watson-Jones ankle tenodesis is widely used to relieve lateral hindfoot instability (Gillespie and Boucher 1971, Lucht et al. 1981, Fox and Dolan 1987). However, a distinct observation in patients having had the tenodesis is restriction in movements in the hindfoot (Anderson and LeCocq 1954, Gillespie and Boucher 1971, Habekost et al. 1978, Hedeboe and Johannsen 1979, Horstman et al. 1981, Lucht et al. 1981, Casting et al. 1984, van der Rijt and Evans 1984, Cass et al. 1985, Barbari et al. 1987, Fox and Dolan 1987). Although complaints of reduced motion in the hindfoot are seldom reported following lateral ankle tenodeses, a change of the range of movements may have late consequences. This was shown by Milachowski and Wirth (1988), who found arthrosis to be more common in hindfeet with chronic instability treated with tenodesis as compared with dural reconstruction or ligament advancement.

The calcaneofibular ligament is the primary stabilizer of adduction in the hindfoot, loaded as well as unloaded (Stormont et al. 1985, Kjærsgaard-Andersen et al. 1987a, b), whereas the anterior talofibular ligament is the primary stabilizer of internal rotation (Rasmussen and Tovborg-Jensen 1982, Stormont et al. 1985). Following a combined lesion to these ligaments, we found the Watson-Jones tenodesis to restrict adduction and internal rotation in the total hindfoot joint complex and in the talocalcaneal joint. Restriction in adduction was due to the direction of the first limb of the tenodesis from the basis of the fifth metatarsal bone to the posterior part of the distal fibula. Both during adduction and internal rotation, the distance between these landmarks increased gradually. Therefore, a rigid fixation by the lesser peroneal tendon of this distance always resulted in a restriction in adduction and internal rotation in the hindfoot joints.

The inability of the Watson-Jones tenodesis to stabilize external rotation due to lesion of the calcaneofibular ligament (Kjærsgaard-Andersen et al. 1987a, b) is explained by the fact that the first limb of the tenodesis is perpendicular to the anatomic direction of the ligament. This was confirmed during our tests, as the first limb of the tenodesis was noticed to relax when performing an external rotatory movement.

A major condition which may have influenced the results in the present study was the position of the hindfoot joints during the application of the tenodesis. We used a neutral position, whereas others prefer to perform the tenodesis with the hindfoot slightly abducted (Anderson and LeCocq 1954, Habekost et al. 1978, Lucht et al. 1981). Our study indicates that such a position may further reduce adduction and probably also internal rotation.

In conclusion, the tested modified Watson-Jones ankle tenodesis does not restore normal hindfoot kinematics. This goal seems only attainable by a procedure exactly reproducing the anatomic orientation of the injured lateral ligaments (Colville et al. 1987).

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