KEMA
Kinetic Ergocise based on Movement Analysis

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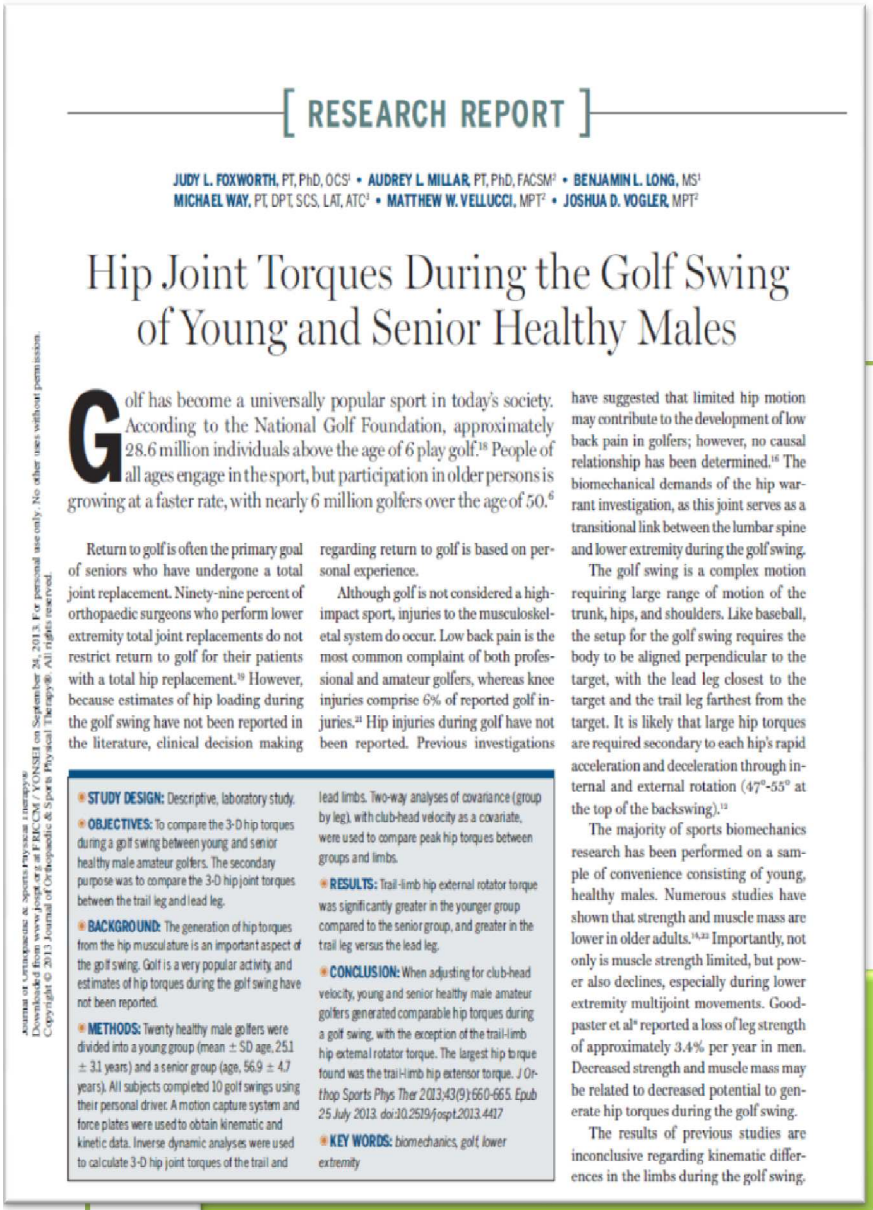

[RESEARCH REPORT]

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Hip Joint Torques During the Golf Swing of Young and Senior Healthy Males

Golf has become a universally popular sport in today's society. According to the National Golf Foundation, approximately 28.6 million individuals above the age of 6 play golf.[18] People of all ages engage in the sport, but participation in older persons is growing at a faster rate, with nearly 6 million golfers over the age of 50.[6]

Return to golf is often the primary goal of seniors who have undergone a total joint replacement. Ninety-nine percent of orthopaedic surgeons who perform lower extremity total joint replacements do not restrict return to golf for their patients with a total hip replacement.[19] However, because estimates of hip loading during the golf swing have not been reported in the literature, clinical decision making regarding return to golf is based on personal experience.

Although golf is not considered a high-impact sport, injuries to the musculoskeletal system do occur. Low back pain is the most common complaint of both professional and amateur golfers, whereas knee injuries comprise 6% of reported golf injuries.[21] Hip injuries during golf have not been reported. Previous investigations have suggested that limited hip motion may contribute to the development of low back pain in golfers; however, no causal relationship has been determined.[16] The biomechanical demands of the hip warrant investigation, as this joint serves as a transitional link between the lumbar spine and lower extremity during the golf swing.

The golf swing is a complex motion requiring large range of motion of the trunk, hips, and shoulders. Like baseball, the setup for the golf swing requires the body to be aligned perpendicular to the target, with the lead leg closest to the target and the trail leg farthest from the target. It is likely that large hip torques are required secondary to each hip's rapid acceleration and deceleration through internal and external rotation (47°-55° at the top of the backswing).[12]

The majority of sports biomechanics research has been performed on a sample of convenience consisting of young, healthy males. Numerous studies have shown that strength and muscle mass are lower in older adults.[14,23] Importantly, not only is muscle strength limited, but power also declines, especially during lower extremity multijoint movements. Goodpaster et al[14] reported a loss of leg strength of approximately 3.4% per year in men. Decreased strength and muscle mass may be related to decreased potential to generate hip torques during the golf swing.

The results of previous studies are inconclusive regarding kinematic differences in the limbs during the golf swing.

STUDY DESIGN: Descriptive, laboratory study.

OBJECTIVES: To compare the 3-D hip torques during a golf swing between young and senior healthy male amateur golfers. The secondary purpose was to compare the 3-D hip joint torques between the trail leg and lead leg.

BACKGROUND: The generation of hip torques from the hip musculature is an important aspect of the golf swing. Golf is a very popular activity, and estimates of hip torques during the golf swing have not been reported.

METHODS: Twenty healthy male golfers were divided into a young group (mean ± SD age, 25.1 ± 3.1 years) and a senior group (age, 56.9 ± 4.7 years). All subjects completed 10 golf swings using their personal driver. A motion capture system and force plates were used to obtain kinematic and kinetic data. Inverse dynamic analyses were used to calculate 3-D hip joint torques of the trail and lead limbs. Two-way analyses of covariance (group by leg), with club-head velocity as a covariate, were used to compare peak hip torques between groups and limbs.

RESULTS: Trail-limb hip external rotator torque was significantly greater in the younger group compared to the senior group, and greater in the trail leg versus the lead leg.

CONCLUSION: When adjusting for club-head velocity, young and senior healthy male amateur golfers generated comparable hip torques during a golf swing, with the exception of the trail-limb hip external rotator torque. The largest hip torque found was the trail-limb hip extensor torque. *J Orthop Sports Phys Ther 2013;43(9):660-665. Epub 25 July 2013. doi:10.2519/jospt.2013.4417*

KEY WORDS: *biomechanics, golf, lower extremity*

연령별 건강한 남성들의
골프 스윙 시
엉덩관절의 토크

Hip Joint Torques During the Golf Swing of

Young and Senior Healthy Males

◆ 골프는 고충격 스포츠는 아니지만, 근골격계 손상이 자주 발생된다. 골프 손상 중 허리 통증이 가장 흔하며, 무릎 통증은 6%으로써 가장 낮다. 약 99%의 정형외과의는 total hip replacement를 받은 환자들이 골프를 재개하는 것을 제한하지 않는다.이전 문헌들에서 골프 스윙 시 엉덩관절의 발생되는 부하 측정값이 보고되지 않았기에, 골프를 재개하는 것은 개인적 경험을 바탕으로 한다. 이에 이 연구는 첫 번째로 젊은층과 중년층의 건강한 아마추어 골퍼들을 대상으로 골프 스윙 시 고관절에서 발생되는 토크를 측정하고, 두 번째로 양발 간 엉덩관절의 토크 값을 비교하고자 한다.

실험 방법

◆ 10명의 건강한 젊은 아마추어 골퍼(평균 나이 25.1세)와 10명의 건강한 중년 아마추어 골퍼(평균 나이 56.9세)가 연구에 참여.

◆ 모든 실험자들은 10회씩 골프 스윙을 수행. 이때 운동 분석 시스템과 force plate를 사용하여 움직임과 힘 측정.

실험 방법

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실험결과

1. 젊은 골퍼 군의 외회전 최고 토크가 중년 골퍼 군에 비해 높음.
2. 오른발과 왼발 비교에서 오른발의 외회전 최고 토크가 더 큼(오른손이 우세 손일 경우).
3. 클럽 헤드의 속도와 엉덩관절의 토크는 중간 정도(moderate)의 상관관계를 보임.

TABLE 1 PARTICIPANT DEMOGRAPHICS FOR THE 2 GROUPS*

Group	Age, y	Body Mass Index, kg/m²	Handicap	Peak Club-Head Velocity, m/s†
Young	25.1 ± 3.1	24.5 ± 3.4	11 ± 6.7	41.9 ± 4.5 (38.7, 45.1)
Senior	56.9 ± 4.7	27 ± 2.3	9 ± 3.7	40 ± 3.5 (37.5, 42.5)

*Values are mean ± SD.
†Values in parentheses are 95% confidence interval.

TABLE 2 INTERNAL PEAK HIP TORQUES*

Peak Hip Torque	Young (n = 10)†	Senior (n = 10)†	Combined (n = 20)
Trail-leg extensor	11.06 ± 2.49 (9.76, 12.37)	10.22 ± 1.23 (8.92, 11.53)	10.64 ± 1.96
Lead-leg extensor	5.32 ± 1.52 (4.46, 6.20)	5.23 ± 1.05 (4.36, 6.10)	5.28 ± 1.27
Trail-leg flexor	6.61 ± 2.13 (5.43, 7.79)	6.52 ± 1.33 (5.34, 7.70)	6.56 ± 1.73
Lead-leg flexor	6.55 ± 1.21 (5.43, 7.67)	6.74 ± 2.05 (5.62, 7.86)	6.64 ± 1.64
Trail-leg adductor	5.55 ± 2.02 (4.33, 6.76)	4.35 ± 1.61 (3.14, 5.57)	4.95 ± 1.88
Lead-leg adductor	2.18 ± 1.45 (1.42, 2.93)	1.65 ± 0.68 (0.90, 2.41)	1.91 ± 1.14
Trail-leg abductor	5.44 ± 1.3 (4.64, 6.25)	5.93 ± 1.11 (5.13, 6.74)	5.69 ± 1.21
Lead-leg abductor	6.85 ± 1.73 (5.38, 8.33)	5.75 ± 2.62 (4.27, 7.22)	6.30 ± 2.23
Trail-leg internal rotator	2.82 ± 1.57 (2.04, 3.60)	2.58 ± 0.55 (1.80, 3.37)	2.7 ± 1.15
Lead-leg internal rotator	3.41 ± 1.07 (2.75, 4.08)	3.01 ± 0.92 (2.35, 3.67)	3.21 ± 0.99
Trail-leg external rotator	2.71 ± 0.84 (2.19, 3.24)‡	2.05 ± 0.74 (1.53, 2.58)	2.38 ± 0.84§
Lead-leg external rotator	1.68 ± 0.53 (1.40, 1.97)‡	1.17 ± 0.30 (0.89, 1.46)	1.43 ± 0.49

*Values are mean ± SD percent body weight times height.
†Values in parentheses are 95% confidence interval.
‡When averaged across limbs, peak external rotator torque was greater in the young group compared to the senior group.
§When averaged across groups, the peak external rotator torque was greater in the trail limb compared to the lead limb.

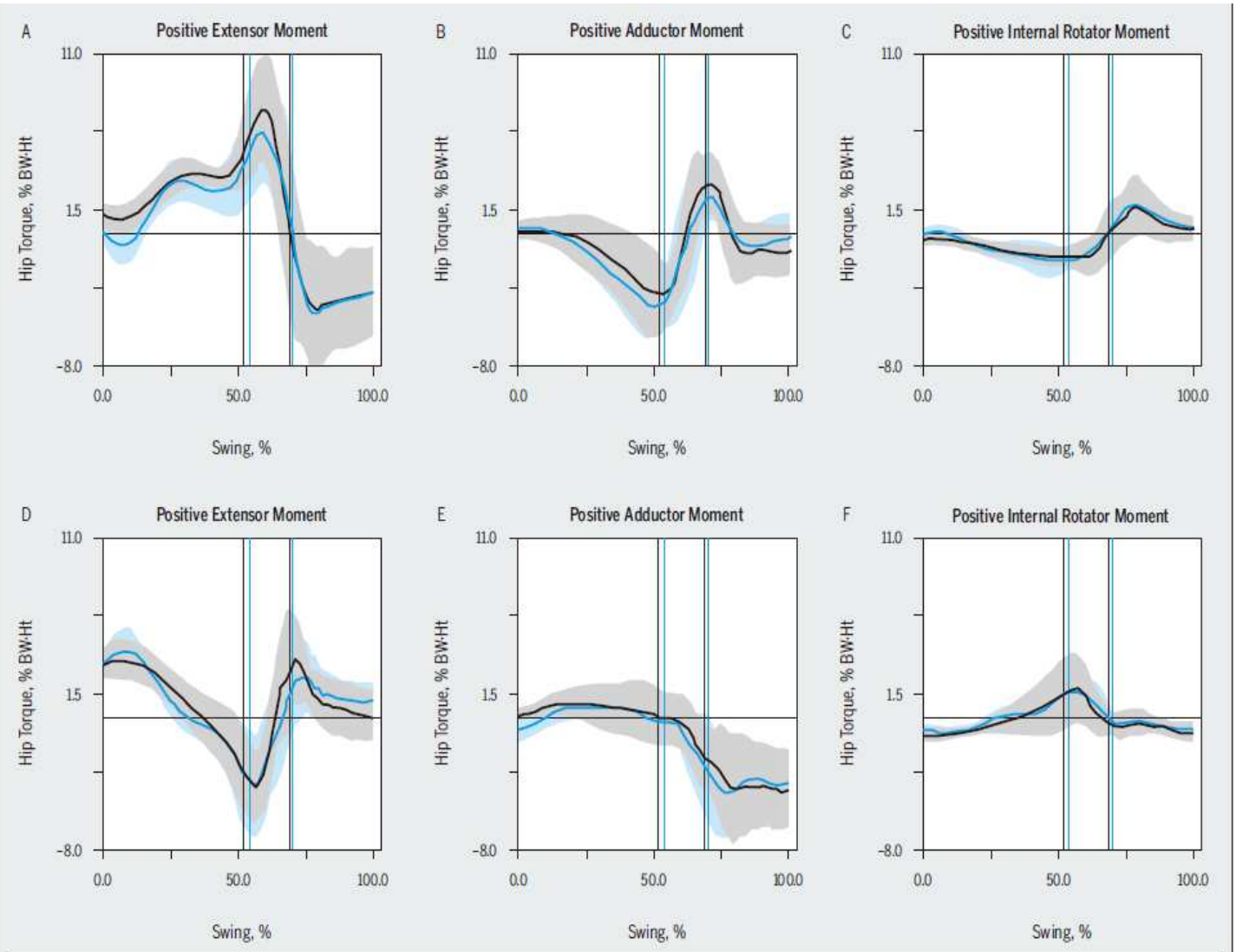

FIGURE 2. Ensemble averages of 3-D hip torque curves of (A) trail-limb hip sagittal plane moments, (B) frontal plane moments, (C) transverse plane moments, (D) lead-limb hip sagittal plane moments, (E) frontal plane moments, (F) transverse plane moments of both the young and senior groups. The young group (n = 10) is depicted by the black line and the senior group (n = 10) is depicted by the blue line. The shaded areas are the group standard deviations. The first vertical line marks the beginning of the downswing and the second vertical line marks ball contact. Abbreviation: % BW·Ht, percent body weight times height.

TABLE 3

Correlations Between Club-Head Velocity (m/s) and Peak Hip Torques

	Trail Leg		Lead Leg	
Hip Torque	**Pearson *r***	***P* Value**	**Pearson *r***	***P* Value**
Internal rotator	0.64	.002	0.65	.002
External rotator	0.60	.005	0.01	.958
Flexor	0.56	.01	0.49	.029
Extensor	0.46	.042	0.59	.006
Abductor	0.09	.712	0.30	.192
Adductor	0.56	.01	0.39	.089

요약

◆ 이 연구의 결과

클럽 헤드 속도를 조정할 때, 골프 스윙 시 젊은 층과 중년 층의 아마추어 골퍼들은 오른발의 엉덩관절 외회전 토크를 제외하고, 비슷한 엉덩관절 토크를 발생한다. 발견된 가장 큰 엉덩관절 토크는 오른발의 엉덩관절 외회전 토크이다.

◆ 의미

전형적인 골프 스윙 시 발생되는 엉덩관절 토크의 수량화는 임상가들이 이런 활동들을 위한 엉덩관절 근육 동원들을 이해하는데 도움을 줄 수 있다. 골프를 재개하는 결정은 손상 측과 스윙 시 클럽 헤드 속도를 고려해야 한다.

◆ 주의

이 연구의 결과는 건강한 남성 골퍼들에게만 일반화되어야 한다. 엉덩관절 근육 약화가 엉덩관절 토크에 어떠한 영향을 미치는지 또는 여성 골퍼들에게는 생체역학적 차이가 존재하는지에 대해서는 알 수 없다.

-KEMA 책임 연구원 정성대-

-문의사항은 KEMA 홈페이지 기사에 댓글로 남겨주세요-

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