

Do Prophylactic Knee Braces Prevent Knee Injury in College and High School Football Players?

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Objectives

- Provide a background of knee injuries in football players, statistics on knee injuries in this population and etiologies of knee injury in football players
- Identify differences between prophylactic, functional and post-surgical knee braces
- Provide a brief background and history of prophylactic knee bracing
- Discuss individual studies to highlight important findings and limitations
- Summarize the overall findings from laboratory-based studies and those that compared data from actual high school and college-football players on the effectiveness of prophylactic bracing
- Articulate how the research can be discussed with patients seeking guidance with their decision to use a prophylactic brace

Football and Injuries

- Most popular high school sport in United States
 - 1 million+ males participated in high school football in the 2012-2013 academic year¹
- Rechel et al. (2011) compared injury data among high school athletes²
 - Football had the highest rate of any high school sport
 - 2.52 per 10,000 athlete-exposures
 - Competition: 8.65
 - Practice: 1.27
 - 44.9% of high school football injuries occurred at the knee

- Bradley et al. (2008) collected injury data on participants at 2005 NFL Combine (N=332)³
 - 54% (179/332) of participants had a prior history of knee injury
 - 68% of defensive linemen
 - 57% of tight ends and offensive linemen
 - Seventy-nine players had experienced a medial collateral ligament (MCL) injury
 - Meniscus: n = 51
 - ACL: n = 40

- MCL injuries occur when a lateral blow creates a valgus moment at the knee, creating tension on the MCL and compression laterally at the tibiofemoral joint



Types of Knee Braces⁴

- Prophylactic
 - Intended to be worn by individuals without prior knee injury to prevent or reduce the severity of injury
- Functional
 - Intended to provide stability to unstable knees that have been injured previously
- Post-surgical
 - Designed to limit the range of motion in injured and/or post-operative knees

Prophylactic Braces^{5,6}

- 1977: Oakland Raiders athletic trainer George Anderson designed the first prophylactic brace to protect the knee of QB Ken Stabler
- Anderson tested the brace on 9 additional players over a short duration (1-9 games)
 - No knee injuries in those wearing brace
 - Proposed that brace was effective at reducing injury to the medial side of the knee
 - Also hypothesized that the brace restricted anterior-posterior displacement

- Currently, prophylactic bracing is most commonly observed in collegiate offensive linemen⁷



Research on Prophylactic Bracing



Laboratory Studies

- Six studies evaluated the protective benefits of prophylactic braces with mixed results
 - Three studies tested braces on cadaveric lower extremities ^{8,9,10}
 - Three studies tested braces applied to human subjects and/or a mechanical surrogate lower extremity ^{11,12,13}

- Paulos et al. (1987) identified four possible negative consequences of wearing prophylactic knee braces¹⁰:
 - Center axis shift
 - MCL Preload
 - Premature joint line contact
 - Brace slippage

- Center axis shift
 - Refers to the lateral shift in the axis of valgus rotation away from the center of the knee and towards the knee brace
 - Authors commented that this could have directed force away from the MCL and towards other cruciate ligaments, primarily the ACL
 - Cited as a possible explanation for why the ACL in the braced knees experienced increased loading during failure testing, and why ligamentous failure occurred at 2 mm less medial joint line opening in the braced than unbraced knees

- MCL preload
 - Increased MCL tension prior to the application of valgus impact
 - Contributed to additional valgus force at the knee
- Premature joint line contact
 - Occurs when the brace hinge collides with the tibiofemoral joint line
 - Creates three-point bending at the joint line, increasing the stress on the stabilizing structures of the tibiofemoral joint
 - If brace failure occurs prior to joint line contact, or at the same time, this will concentrate energy to the joint line

- Pre-load was later refuted by France et al.¹¹
 - Tension on MCL from brace was determined to be too low to predispose the ligament to injury
 - Any preload would be negated by the increased joint compression from weight-bearing and dynamic stability from muscle action by the athlete
- France et al. observed joint line contact with each of the braces tested.
 - Some provided resistance to valgus load despite contacting the joint line
 - Others deformed prior to contacting the joint line and offered no protection
- France et al. also commented that center axis shift was likely not a significant factor to predispose an individual to injury

- Findings from two studies suggest a possible cushioning effect from bracing, resulting in reduced impact momentum at the knee^{9,12}
- This cushioning effect on ligaments is unclear
 - Erickson et al. reported a non-significant reduction in peak MCL strain, but not ACL strain⁹
 - Paulos et al. (1991) reported that braces increase the onset time of MCL-ACL ligamentous tension¹²
 - Paulos et al. also found that both ACL and MCL peak force were reduced, with the greatest reduction in ACL peak force
 - Mean reduction in MCL peak load: 21.95% +/- 6.92%
 - Mean reduction in ACL peak load: 38.9% +/- 15.32%.

Impact Safety Factor (ISF)^{11,12}

- $ISF = \left[\frac{\text{Ligament peak tension, unbraced} / \text{impact momentum, unbraced}}{\text{ligament peak tension, braced} / \text{impact momentum, braced}} \right]$
- ISF of 1.50 represents a 30% reduction in ligament force in braced vs. unbraced conditions
- Paulos et al. (1991) Mean ISF¹²:
 - MCL: 1.29 +/- 0.12
 - ACL: 1.78 +/- 0.60

- Paulos et al. concluded that while braces reduced peak forces at both the MCL and ACL, the ACL received the most benefit¹²
- France et al. found that only one brace out of the six tested had a beneficial mean ISF¹¹
 - DonJoy = 1.51
 - Evidence was not strong enough to support or discourage the use of prophylactic knee braces to protect the ligaments of the knee

- Salvaterra et al. found no difference in medial joint line opening between braced and unbraced knees.¹³
 - Subjects were tested in long-sitting (open chain) position, which does not accurately reflect the loading conditions experienced during athletic competition



Summary of Laboratory Studies

- Overall the results from studies performed under laboratory conditions do not conclusively support that prophylactic braces increase or decrease the risk of knee injury
- There may be some protective benefit to the ACL, but the MCL does not appear to be protected sufficiently to prevent injury

Injury Statistics in Braced vs. Unbraced Players



College and High School Players

- Overall, studies on the effectiveness of prophylactic bracing to prevent knee injury in college and high school football players do not collectively endorse or discourage their use
 - Data from two studies suggest a reduced risk of injury ¹⁴ (sitler),¹⁷ Albright
 - Researchers determined an increased risk of knee injury in four studies¹⁶ Rovere,¹⁸ Tetiz,¹⁹ Grace,²³ Zemper
 - No difference in injury occurrence or severity between braced and unbraced players in three studies¹⁵ Hewson,²¹ Deppen,²² Albright

College Athletes

- Sitler et al. performed the lone randomized controlled trial in 1990.¹⁴
- Subjects were members of the intramural 8-man football team at the United States Naval Academy
- Participants (N = 1,396) randomly allocated to intervention or control group
 - Intervention group: Received bilateral prophylactic knee braces to be worn at all games and practices
 - Control group: Did not wear any knee braces during games or practices

- Results

- Braced group experienced a significant reduction ($p < 0.005$) reduction in total MCL injuries
- Nonsignificant reductions in ACL and contact-related MCL injuries
- Reduced knee injury rate in the braced group (1.50 per 1,000 exposures) than the control group (3.4 per 1,000)
- No statistically significant differences in MCL or ACL knee injuries

- Two studies analyzed data across multiple seasons in which players wore braces vs. seasons in which braces were not worn by any of the athletes.^{15,16}
 - Hewson et al. (1986): Assessed “at risk” players on a Division I college football team (offensive linemen, defensive linemen, tight ends and linebackers)¹⁵
 - None wore braces (fall 1977-spring 1981)
 - All “at risk” players wore braces (fall 1981 – spring 1985)
 - Rovere et al. (1987)¹⁶
 - All players on Division 1 college football team wore braces (fall 1983, spring and fall of 1984, and spring 1985)
 - None wore braces (spring and fall of 1981 and 1982)

- Hewson et al. reported similar knee injury totals (ACL, MCL, meniscus) between braced and unbraced seasons for “at risk” players.¹⁵
 - No statistically significant differences between braced and unbraced periods
 - Slightly lower knee injury rates in unbraced seasons
 - OL, DL, TE and LB determined to be at twice the risk of knee injury than other positions
- Rovere et al. – Knee injury rate was higher in the braced seasons than unbraced.¹⁶
 - 7.5 per 100 players vs. 6.1 per 100 players
 - Twice as many knee surgeries in braced years

- Teitz et al. (1987) reported a statistically significant increase in knee injuries to braced players across two seasons.¹⁸
 - Significantly more MCL injuries in the braced players
 - Significantly more meniscal tears in braced players in 2nd season of study, but not the 1st
 - No difference in injury severity between groups
- Zemper (1990) also determined a statistically significant increase in total knee injuries for the braced players than unbraced.²³
 - No difference in MCL injuries

- Three studies included only data from high school football players^{19,20,21}
 - Grace et al. conducted a two-year observational study, and found significantly more knee injuries in braced than unbraced players ($p < 0.01$).¹⁹
 - Athletes wearing single-hinged knee braces experienced significantly more injuries than controls ($p < 0.001$)
 - Non-significant injury increase in players wearing double-hinged knee braces vs. controls
 - In the 2nd year, there were 3x more injuries in the braced group than controls

- Deppen et al. (1994): No difference in total knee injuries or knee injury severity between braced and unbraced players.²¹
 - Braced players: 23 knee injuries in 21,640 athlete-exposures
 - Unbraced players: 26 knee injuries in 19,484 athlete-exposures
- Yang et al. (2005) assessed the use of knee braces in multiple high school sports including football, and noted an increased risk of knee injury in braced players.²⁰

Systematic Reviews

- Pietrisomone et al. included seven studies on college football players and prophylactic knee braces²⁴
 - Calculated Relative Risk Reduction (RRR), Relative Risk Increase (RRI), Numbers Needed to Treat to Benefit (NNTB), and Numbers Needed to Treat to Harm (NNTH) from the reviewed studies
 - Three studies yielded relative risk reductions in knee injuries which ranged from 10-56%
 - Four studies had a relative risk increase ranging from 17-114%

- NNTB: 17 and 32 were determined from two studies
- NNTH of 32 found in two studies
- Infinity was included in the 95% confidence of three studies, indicating that the affect of the brace on injury could not be determined
- Review concluded that the available research is inconclusive and knee braces cannot be endorsed or discouraged
 - Better quality studies are needed before the relationship between brace wear and knee injury can be truly understood

- Salata (2010) reviewed six studies which compared data on braced and unbraced college football players.²⁵
 - Authors concluded that the available research is inconclusive in regards to the efficacy of knee braces to prevent knee injury in college football players



Summary of Findings

- No conclusive findings support the use of prophylactic knee braces to prevent knee injuries in college or high school athletes
- The MCL was the most common site of injury in braced and unbraced football players.^{14,15,16,17,18,21}
- Offensive linemen appear to be at the greatest risk for knee injuries, followed by defensive linemen, tight ends and linebackers.^{15,18,19,20,24}

- The risk of injury is higher in games than during practices.^{15,16,17,18,21,23}
- Knee injuries occur result more frequently from contact than non-contact^{14,16,21,23}
 - One study reported more likely to occur while blocking or while being blocked.²³
- No brace manufacturer is proven to be more effective than another at protecting the knee.^{18,23}
- The American Academy of Orthopaedic Surgeons) do not recommend the use of knee braces to prevent knee injury in football players.²⁵

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