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Medial Collateral Ligament Knee Sprains in College Football

Effectiveness of Preventive Braces

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ABSTRACT

This is the second of 2 articles on a 3-year investigation of medial collateral ligament sprains of the knee to assess the effectiveness of prophylactic knee braces in NCAA Division I college football players. Position, string, type of session, and daily brace wear were recorded. The injury rates for braced and unbraced knees were used to create an incidence density ratio. The data were stratified and simultaneously controlled for position, string, and session and evaluated for their statistical significance. The 987 Big Ten players generated 155,772 knee exposures over the study period (50% braced). Noticeable differences existed in the rates of injury for the braced and unbraced knees in almost every position during practices, depending on player or nonplayer status. When the influential factors of position, string, and session are considered, there is a consistent but not statistically significant tendency for the players wearing preventive knee braces to experience a lower injury rate than for their unbraced counterparts. For starters and substitutes in the line positions, as well as the linebackers and tight ends, there was a consistent trend toward a lower injury rate in both practices and games. The braced players in the skill positions (backs/kickers), at least during games, exhibited a higher injury rate.

Introduction of the preventive knee brace to the National Football League in 1979[1] stimulated demand from coaches, parents, and booster clubs that these devices be used for all levels of football. Since their introduction, the research regarding their true efficacy has been mixed, at best. Warnings regarding the negative aspects of brace wear began to emerge from various medical groups in the mid-1980s. These concerns culminated with a position statement regarding the use of prophylactic braces from the American Academy of Orthopaedic Surgeons. This Academy cited evidence from numerous authors[2,7,8,10,13,17–19] that indicated that these devices had not been shown to be effective for preventing knee injuries and that they might even be associated with an increased frequency and severity of injury.

Despite the uncertainty regarding their protective quality, use of preventive knee braces has not diminished at the college and professional levels. Cadaveric studies[3,5,6,12,15] indicate that these braces may provide additional resistance[4] to medial joint line opening when a valgus force is applied to the knee in near-full extension. At the same time, they indicate that prophylactic knee braces have very little effectiveness in preventing a medial collateral ligament (MCL) injury when the knee is flexed.

Part I of this study (see page 2) delineates the purpose of and parameters for this research by the Big Ten Conference Sports Medicine Committee. The data collection expertise of the conference membership in the National Athletic Injury/Illness Reporting System (NAIRS) and its own injury reporting system, as well as a common interest in the topic of preventive knee braces, was combined as a cooperative research project into an initial pilot study. Based on the descriptive study experience, as well as results from contemporary cadaveric-based biomechanical research regarding the effectiveness of off-the-shelf knee braces, the Big Ten knee study was implemented.

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METHODS

An addendum to the ongoing Big Ten Injury Reporting System Handbook established the operational definitions, evaluation procedures, and recording materials for the knee brace study. These materials were distributed to all head athletic trainers and head team physicians before the first season. Each recorder knew which athletes were to be included, the definition and terminology of reportable injuries, and the specific variables to be included in the record. The availability of these materials to the recorder before the beginning of the data collection process, as well as the use of several check points before the data base was finalized, improved the accuracy of the data that were collected.

Participation in the study was voluntary and required that a student athletic trainer be assigned to record daily attendance and brace wear rosters. This recorder was responsible for accurate recording and transmission of the MCL injury data defined by the athletic training staff and the team physician.

Subjects

At the beginning of each of the 3 seasons, all team members were screened for their eligibility for inclusion in the study. The decision to select only virgin knees was made on the basis of the pilot study finding that the first injury had been noted, on occasion, to impair the agility of the athlete, which may have made him more susceptible to injury. There were 987 subjects that accounted for 1431 player-seasons in the 3 years of this study. Many subjects were in the study for more than 1 year without incurring an MCL sprain or terminating for any other reason. Of the original 388 subjects at the outset of the study in 1985, 92 began all 3 years with their names listed in the daily attendance and brace wear rosters. Of these, 76 can truly be said to have completed the 3-year period without incurring a knee injury.

Injury

The injuries included in the data analysis pertained to the MCL of the knee—specifically, those injuries that were clinically defined as maximum tenderness located over the anatomic region of the MCL or pain elicited with valgus stress of the knee flexed 20° to 30°, or both. The diagnosis of the specific knee injury was determined by the team athletic trainer and the team physician by the establishment of tissue damage, whether or not any time lost from action was associated with the injury. An MCL sprain could include an MCL injury plus other injuries to the knee, e.g., MCL plus ACL sprain.

Knee exposures

The "knee exposure" term is used in this study to express the number of opportunities that knees (2 per player) were exposed to a sport-related risk of injury. The 987 different athletes in the 3-year study population accumulated 155,722 knee exposures; these exposures will be used as the denominator for the injury rate calculations.

Preventive or prophylactic knee brace

For the purpose of this study, a preventive brace is defined as any device designed specifically to provide protection from a lateral blow to the knee that would otherwise result in an MCL sprain. These usually off-the-shelf devices are self-suspending about the knee, with single or double upright brace and joints that allow knee flexion and extension. They are made of various types of material from plastic to metal.

Brace status at the time of injury

The details about the braces were recorded from the initial examination findings on the field. Of interest was whether or not the brace had been damaged during the blow and whether it was properly placed at the time of the injury. The brace status was "normal" or "abnormal" for damage, and the position status was recorded as "proper" or "improper." Most of the braces associated with injury (51 of 54) were not deformed by the injury and were in the proper position at the time of injury. No further analysis of these factors will be considered at this time.

Position

At the time of each injury, the player's position was recorded. The position groups were line (offensive line, defensive line, and defensive end), linebacker/tight end, and skill (offensive and defensive backs and kickers).

Session

Sessions were coded and recorded as regular practice, scrimmage, light practice, no-contact practice, and games. The analysis of the injury pattern for braced and unbraced conditions included regular practice, scrimmage, and games.

Data analysis

Much of the existing data regarding the injuries associated with the use of the prophylactic knee brace has been limited to examining the frequencies and proportions of injuries that occur under different conditions.[7,9,10,13] The data have been presented as frequency, percentages, and injury rates. In these studies, the frequency and relative frequency (injury rate) were computed from aggregated data recorded from the numerous institutions. When studying the injury patterns associated with college football, it is important to keep in mind that no single factor causes a specific injury. Considerations of the multifactor nature of the injury scenario must be employed if the idea of the risk of injury is to be used.

Recently, Sitler et al.[18] conducted a study of knee injuries and brace wear using the multifactor approach. They employed control variables with two-dimensional tables to estimate the expected frequencies within the cells of a cross-classification table of braced and unbraced knee injuries. The table reflected braced and unbraced injuries by position and session.

The current study examines the injury rates for Big Ten football knee injuries and exposures and considers the influence of the prophylactic knee brace with the control factors of position group, string, and type of session. Injury rates are computed to reflect the number of knee injuries compared with the number of opportunities for a knee to be injured (knee exposures). With the braced/unbraced status as the reference variable, the data are stratified to reflect the injury rate comparisons for the categories of the control variables. These comparisons are accomplished by dividing the injury rate for the braced group (experimental) by the injury rate of the unbraced group (control). This calculation is called the crude incidence density ratio (cIDR) and reflects the data before any control variables are introduced. If there are no differences in the injury rates for the two categories, the cIDR equals 1. A cIDR greater than 1 indicates the experimental injury rate (braced) is higher than the control (unbraced). The converse is true if the cIDR is less than 1.

The data are stratified for the position group, type of session, and string and then simultaneously included in a three-dimensional table. Comparisons were made of the injury rates for braced and unbraced conditions. To test the null hypothesis of no difference between the stratified IDRs and an IDR of 1, a procedure that uses a standard normal approximation to the binomial distribution was selected.[11] A probability value of less than or equal to 0.05 for a two-sided test is statistically significant. Test-braced 95% confidence intervals were calculated according to Miettinen.[14]

RESULTS

The 987 different varsity football players (1974 different knees) in the study accounted for 1431 player seasons, 2862 knee seasons, and 155,722 knee exposures during the 1985, 1986, and 1987 study years. This represented nearly 40.8% of all of the football players in the conference. There were 78,911 of 55,722 knee exposures (50.7%) in players with prophylactic knee braces and 76,811 (49.3%) in players who wore no braces. In practice, 91% of the knee exposures were in braced players and 84.2% were in unbraced players. In games, 36.7% of the exposures were to braced knees (Table 1). The line positions group accounted for most braced exposures (47.8% in practices and 64.5% in games). The linebacker/tight end and skill positions groups shared the characteristic of wearing braces with a greater regularity in practices than in games (Table 1).

TABLE 1
Athlete knee exposures by string, position, position group, and session

	Practice		Game	
	Braced	Unbraced	Braced	Unbraced
String				
Starters	19,669	22,497	3,089	5,176
Substitutes	21,012	19,367	2,427	3,921
Nonplayers	31,172	22,792	1,542	3,058
Total	71,853	64,656	7,058	12,155
Positions				
Offensive line	22,554	4,365	2,849	733
Defensive end	2,193	632	278	80
Defensive line	9,609	4,257	1,423	635
Tight end	5,774	4,008	588	946
Linebacker	9,797	9,054	881	1,898
Quarterback	3,802	5,584	262	956
Wide receiver	5,945	12,407	192	2,549
Defensive back	5,160	12,888	121	2,284
Offensive back	3,325	6,332	144	1,197
Kicker	542	4,361	000	695
Other	3,152	768	320	182
Total	71,853	64,656	7,058	12,155
Position group				
Ol/De/Dl[a]	34,356	9,254	4,550	1,448
Linebacker/ tight end	15,571	13,062	1,469	2,844
Backs/kickers	18,774	41,572	719	7,681
Total	71,853	64,656	7,058	12,155

[a] Offensive line/defensive end/defensive line.

TABLE 2
MCL injury frequency and injury rate/100 knee exposures for session, string, position, and position group

	Braced	Rate/ 100 K-E	Unbraced	Rate/100 K-E
Session				
Practice	32	0.045	20	0.031
Game	22	0.312	26	0.213
String				
Starters	21	0.092	28	0.101
Substitutes	9	0.038	11	0.047
Nonplayers	24	0.073	7	0.027
Position				
Offensive line	27	0.106	3	0.059
Defensive end	0		2	0.281
Defensive line	11	0.010	6	0.144
Tight end	1	0.016	4	0.081
Linebacker	8	0.075	7	0.064
Quarterback	2	0.049	5	0.077
Wide receiver	2	0.065	2	0.013
Defensive back	1	0.019	5	0.033
Offensive back	2	0.058	10	0.133
Kicker	0		2	0.040
Position group				
Ol/De/Dl[a]	38	0.095	11	0.103
Linebackers/ tight ends	9	0.053	11	0.069
Backs/kickers	7	0.036	24	0.049

[a] Offensive line/defensive end/defensive line.

Injury frequency

There were 100 MCL ligament sprains that were eligible for inclusion in the data analysis. Table 2 reflects the frequency of injury among the variables used in the analysis. The starters accounted for 49 of the injuries, with substitutes at 20 and nonplayers at 31. There were 52 injuries that occurred in the contact practices and 48 that occurred under game conditions. The offensive line position accounted for 27 injuries, more than twice the number contributed by the positions with the next most frequency, that

of defensive line and offensive backs. When grouped, the line positions accounted for 49 injuries, with the linebacker/tight end and skill positions at 20 and 31, respectively. Eighty-eight injuries were classified as Grade II or less on the injury severity scale.

When injuries by brace wear and session are considered, the data show that 45.8% (22) of the 48 game-related injuries occurred to participants wearing braces, while 54.2% (26) of the injuries occurred to participants without braces. On the other hand, in practice, 61.5% (32) of the 52 injuries were incurred by the braced groups.

MCL injury rates

Table 3 displays the injury rates associated with the overall knee injury frequency before the combination of the control factors into a stratified analysis. The all-study comparison between braced and unbraced injury rates (cIDR) shows a higher rate associated with the braced category. As the data are controlled for players and nonplayers, the players' injury rate favors the brace and the nonplayers' rate indicates a statistically significant higher injury rate for the braced condition ($P < 0.01$). With session as a control, the unbraced condition is favored for both practice and game, and the differences are not significant. When the position category is used as a control, all three groups (line, linebacker/tight-end, and skill positions) favor the use of braces, with none of the differences being significant.

Table 4 examines the injury rates with the type of session as a single control factor and the string not differentiated. Under these conditions, the practice-related injury rates for line and linebacker/tight-end positions are higher for the braced condition, while the injury rates for the skill positions are higher for the unbraced condition. For game-related conditions, this relationship is reversed so that the skill positions show a higher injury rate for the braced condition, and the other two groups show a higher injury rate for the unbraced condition. While differences exist between injury rates, they are not statistically significant.

Table 5 presents the type of session (practice and game) and the position group, considered with the categories of string (players and nonplayers). For players in practice, all position groups show lower injury rates for the braced condition (Fig. 1). Under game conditions, this same group favors the braced knee for the line and linebacker/tight end positions, while the skill positions favor the unbraced condition (Fig. 2).

For the nonplayers' group and the three position groups, the braced injury rates were higher than for the unbraced condition (Fig. 3). The data for this group under game conditions reflect few injuries and few exposures, and do not add to the overall discussion. Under most conditions, these individuals do not play in games and when they do, it is for a very limited time. Among the considerations displayed in Tables 3 through 5, only one relationship attained a statistical significance, the overall category of nonplayers as a single group.

DISCUSSION

Throughout the applicable literature there is one common question that is being addressed: Are players who wear braces more or less likely to sustain an MCL sprain? There is no question that, as Garrick and Requa[5] point out, one of the main reasons that the literature has not already provided an answer is the degree of difficulty involved in collecting and analyzing the data. A large study population is needed, but also needed are sensitive definitions of injury, a dedicated and well-trained, medically knowledgeable data collection system, and a dedicated statistical analysis crew willing to work with the clinicians.

When the current findings regarding the injury rates produced for type of session, string, and position are examined, a consistent trend in injury rates favors the wearing of braces. This is in sharp contrast to the NCAA study reported by Tietz et al.[19] in which there is a general finding of increased injury rate for those wearing braces. If we consider the data without the string as a control factor, our findings may be considered to be in line with the findings of the work by Tietz et al. When string (player and nonplayer) is included, the difference becomes apparent.

These knee results are also consistent with the recent study of 700 West Point cadets published by Sitler et al.[18] In this project, the study group consisted of cadets who had

TABLE 3
Frequency and injury rate per 100 knee exposures for all study participants and MCL knee injuries, 1985–1987

	Braced (N^a)	Unbraced (N^a)	Braced rate	Unbraced rate	IDR	Confidence interval	
						Lower	Upper
All participants	54	46	0.068	0.060	1.14[b]	0.77	1.70
String							
Player	**30**	**39**	0.065	0.077	0.85	0.53	1.36
Nonplayer	**24**	**7**	0.073	0.027	2.71[c]	1.21	6.08
Session							
Game	**32**	**20**	0.312	0.214	1.46	0.83	2.56
Practice	**22**	**26**	0.045	0.034	1.29	0.83	2.51
Position group							
Line positions	**38**	**11**	0.098	0.103	0.95	0.48	1.87
Linebackers/tight ends	9	11	0.053	0.069	0.76	0.32	1.84
Skilled positions	7	24	0.036	0.049	0.74	0.32	1.71

[a] N, frequency of injury.
[b] Crude incidence density ratio for the study.
[c] $P < 0.01$.

TABLE 4
Frequency and injury rate per 100 knee exposures for MCL injuries for all study participants by position group and session, 1985–1987

	Braced (N[a])	Unbraced (N[a])	Braced rate	Unbraced rate	IDR	Confidence interval	
						Lower	Upper
Practice							
Line	**22**	**5**	0.064	0.054	1.19	0.45	3.12
Linebacker/tight end	**6**	5	0.039	0.038	1.01	0.29	3.52
Skilled	**4**	10	0.021	0.024	0.89	0.28	1.71
Game							
Line	**16**	6	0.352	0.414	0.85	0.33	2.16
Tight end/linebacker	**3**	6	0.204	0.211	0.97	0.24	3.87
Skilled	**3**	14	0.417	0.182	2.29	0.68	7.69

[a] *N*, Frequency of injury.

TABLE 5
Frequency and injury rates per 100 knee exposures for MCL injuries for string, position group, and session, 1985–1987

	Braced (*N*[a])	Unbraced (*N*[a])	Braced rate	Unbraced rate	IDR	Confidence interval	
						Lower	Upper
Players							
Practice							
Line	7	**3**	0.034	0.044	0.78	0.20	3.00
Linebacker/tight end	1	**4**	0.013	0.045	0.29	0.04	2.26
Skilled	1	**7**	0.010	0.027	0.36	0.05	2.64
Games							
Line	16	**6**	0.437	0.532	0.82	0.32	2.10
Linebacker/tight end	2	**6**	0.186	0.290	0.64	0.13	3.14
Skilled	3	13	0.606	0.227	2.67	0.80	8.91
Nonplayers							
Practice							
Line	15	**2**	0.107	0.080	1.33	0.31	5.80
Linebacker/tight end	5	**1**	0.063	0.024	2.65	0.34	20.86
Skilled	3	**3**	0.035	0.019	1.89	0.39	9.02

[a] *N*, frequency of injury.

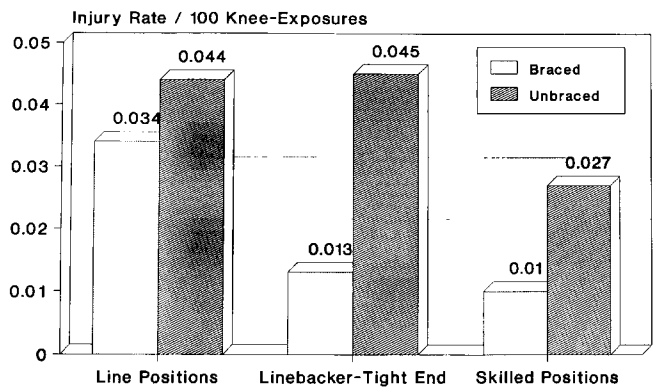

Figure 1. Injury rates for practice—players only.

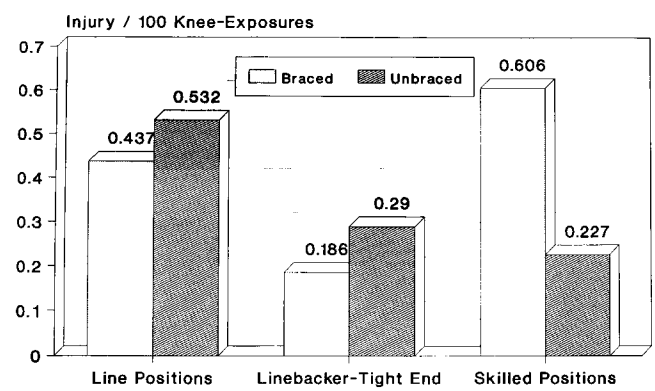

Figure 2. Injury rates for games—players only.

signed up to play 8-man tackle football and who had also had virgin knees. There were a total of 71 knee injuries that included 37 MCL sprains, with 12 occurring to braced cadets and 25 to unbraced cadets. Combining our findings with those of the West Point study provides a strong suggestion that there is some minor influence of braces in the reduction of MCL injuries.

For the starters and substitutes, the trend in favor of the effectiveness of the preventive knee brace was present in all positions, except during games for the skill positions, which includes backs, receivers, and kickers. For the players in games in this group, the injury rate was 0.61 per 100 knee exposures (3/495 × 100). This compares with an injury rate for the unbraced condition of 0.23 per 100 knee exposures (13/5719 × 100). In practice, this group had a braced injury rate of 0.001 per 100 knee exposures (1/10267 × 100) and an unbraced injury rate of 0.027 per 100 knee exposures (7/25535 × 100). If the skill positions group had worn the braces in games with the same pattern as they did in practices, the question arises as to how many injuries would have occurred.

Within the skill positions group, the offensive backs in the player group had 2 braced game injuries and accounted

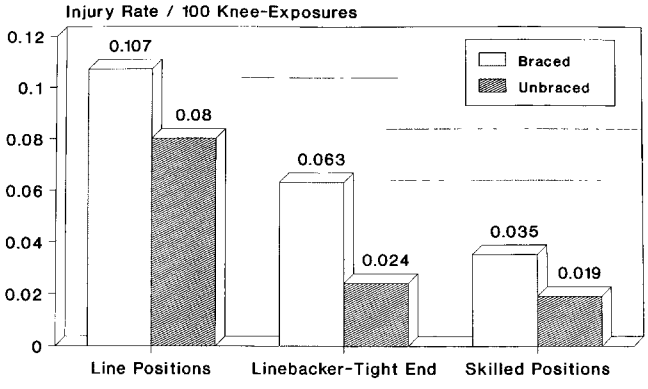

Figure 3. Injury rates for practice—nonplayers only.

for 68 of the braced game exposures. The quarterbacks had 1 braced game injury and 208 of the braced game exposures. For the offensive backs, the braced rate of injury is higher than the quarterbacks. With these small numbers in mind, a detailed consideration of the nature of the activities of the 2 positions during games is important. The open field nature of the offensive back and his ball-carrying responsibility places him at a higher risk of MCL injury than the quarterback who gave him the ball. One would have to question the overall brace wear pattern of the 2 backs that were hurt. They may have chosen to wear their braces for a particular game and, by chance, sustained an injury in that game.

The skill positions group, which shows higher injury rates when the braces are worn, requires analysis that is sensitive to the variation in wear pattern for this group between practice and games. In general, a questioning of this group would probably find that they fear a loss in speed and agility if they are wearing knee braces, especially during games.[16] One must wonder exactly who it is that has chosen to wear braces over the perception of the loss of speed and agility and why. This perception is different for practice and game conditions. The answer may lie in considering the risk of knee injury to skilled players during practice, and the higher speeds and forces during contact under game conditions.

Brace wear was predominant among players in the position groups and sessions of highest risk of knee ligament sprain. For the two position groups (line and linebacker/tight end) that are at greatest risk of MCL injury, the braced injury rates are lower than for the unbraced player. In the braced player, the tendency for reduced risk of MCL sprain is greatest in the linebacker/tight end positions group in both practices and games. While these players wear braces more often in practices than in games, their brace wear pattern is not as high as would be expected from comparing their injury rates with those of the line positions group. In facing the much larger offensive line positions and being involved in many tackles, linebackers, in particular, appear to be at high risk of MCL injury on any running play. On the other hand, on passing plays, they usually have assignments similar to defensive backs, covering much smaller and faster receivers. When questioned about wearing braces, it is this group that is the most torn between protecting their knees and keeping up with the competition. The suggested effectiveness of the knee braces in this group, in particular, is reflected in the IDR (Table 5).

While a true picture must come from prospective analyses, our raw data have suggested that the number of exposures averaged before a braced player sustains an injury may be greater than for a nonbraced player (Fig. 4). In the current study, the starters and substitutes in the line positions had a mean exposure before an injury of 174.9 in the braced knees versus 158.4 when not braced. The linebacker/tight end group wearing braces survived 253 exposures before injury, compared with 123.4 in the unbraced participants. In the nonplayer group, the linebackers/tight ends who were braced survived 109.8 exposures before injury and 26 when the brace was not worn. While discussed in the previous paper, this approach to a longitudinal analysis of each participant has not been previously applied in the field of sports medicine epidemiology, and the ramifications and nuances of the analytical procedure are presently unexplored. The introduction of this analysis and sharing of this information will hopefully provide for the development of this research. It will be of particular value if the injury/exposure index remains parallel to the results of the IDR in future studies. It is clear from our study that there is an important impact of string, session, and position group on the MCL injury pattern as we try to address the preventive quality of the prophylactic knee brace.

CONCLUSIONS

This knee brace study is suggestive but not conclusive regarding the efficacy of knee brace protection from MCL sprains. It provides sufficient information to indicate that further study should be done to prove the role conclusively. These studies should emphasize the role of the several risk factors associated with the risk of knee injury. It establishes specific variables to be included in any interpretive model. The results of this study and those of Sitler et al. are in conflict with those that suggest that the brace is associated with an increased risk of injury. Given the differences in levels of sophistication, a knee brace research project should concentrate on the highest risk groups (e.g., interior line positions in games, nonplayers in practices) as well as on the linebacker/tight end positions group, which shares the risk of injury with the line positions but only wears braces 50% of the time. A study should not only identify the severity of the injury, but be able to evaluate the impact of the knee injury on playing time. If the model is based on injury surveillance techniques, the project should be a nationally coordinated 2- to 3-year study enlisting already proven and enthusiastic experts for the meticulous task of data collection from at least 100 team-seasons for each brace type studied.

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