HELMETS WITH UNEQUAL PREDICT A SIGNIFICANTLY LOWER RISK OF CONCUSSIONS

MAY 12, 2014

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TABLE OF CONTENTS

HELMETS WITH UNEQUAL PREDICT A SIGNIFICANTLY LOWER RISK OF CONCUSSIONS SPRING 2014

I. ABSTRACT

This independent report examines the medical opinion of leading neurosurgeons that helmets with Unequal® supplemental head padding predict a significantly lower risk of concussions. Analysis includes field data gathered on the number of concussions sustained by 1,159 high school players of various ages and skill levels from 14 schools in four states and Canada during the 2013 football season. Results showed a significant reduction in the occurrence of concussions by players who used Unequal Technologies' Gyro® ("Unequal") in various brands and styles of football helmets manufactured by Schutt®, Riddell® and Xenith®. This report evaluates the Virginia Tech® peer-reviewed study on concussion probability, Intertek lab impact tests, ImPACT® neurocognitive data, and my personal experience as a team doctor for a high school football team. Unequal's military grade composite, formulated with Kevlar® and Accelleron, is likely the reason Unequal outperforms typical foam pads. The implications are compelling because this technology can help students both on the field and in the classroom as well as help reverse the downward participation trend in contact sports today.

Quantitatively, the 323 high school players that chose to use Unequal experienced less than a 1% concussion rate. The 836 players that did not use Unequal experienced more than a 9% concussion rate. The results of the 1,159 students from the 14 high schools surveyed are summarized below:

	2013 - Helmets with Unequal		2013 - Helmets NO Unequal	
	# of Players	Concussions	# of Players	Concussions
TOTAL	323	3	836	79
CONCUSSION RATE	1%		9%	
HIGH SCHOOL FOOTBALL PLAYERS	1,159			
HIGH SCHOOLS	14			

II. CONCUSSIONS: THE EPIDEMIC OF OUR AGE

Concussions [1] are the epidemic of our age. In *The Concussion Crisis: Anatomy of a Silent Epidemic*, Carroll and Rosner state that "Estimates by the Centers for Disease Control and Prevention (CDC) range anywhere from 1.6 million to 3.8 million sports-related concussions in the United States annually" (2). Whatever the actual number, in a nation with more than 44 million kids playing contact sports from youth leagues through high school, experts appear to agree that, "The problem has reached epidemic proportions" (5). The American Journal of Sports Medicine states that "Among individuals 15 to 24 years of age, sports are second only to motor vehicle crashes as the leading cause of concussions" (7). The future of contact sports is in jeopardy, according to some, as the trend of fewer young people signing up to play because safety concerns continues (4, 6).

III. BACKGROUND

I am a physician who is fellowship trained in sports medicine and interventional pain; Pain Board certified by the American Board of Physical Medicine and Rehabilitation; and hold a CAQ in Sports Medicine. I am also the football Team Doctor for Liberty Christian High School ("LC"). Recently, Liberty Christian was voted the number one private school in Texas when considering academics, athletics and the arts. The former head coach confirmed 17 reported concussions in 2012 among his football players and noted that some students missed a significant amount of school and their grades dropped as a result of their concussions. Considering the school's prestigious position in the state, he challenged me to decrease the concussion rate and increase student time on the field and in the classroom. We agreed on a two prong approach: First, that all concussions sustained be evaluated by me to ensure the athletes diagnosed with concussive symptoms truly had concussions. This ensured consistent concussion assessment, recovery and return-to-play protocol. Second, was the voluntary implementation of Unequal. The coach permitted me to speak about Unequal with students and parents. This year's Head Coach, Barton Hundley, said "After seeing what Unequal did for our players last season, if I had a boy playing football I wouldn't let him step on the field without Unequal in his helmet."

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[1] The CDC defines concussion as follows: "A concussion is a type of traumatic brain injury (TBI) caused by a bump, blow, or jolt to the head. Concussions can also occur from a fall or a blow to the body that causes the head and brain to move quickly back and forth" (2).

IV. ON-FIELD EXPERIENCES OF CONCUSSION MITIGATION

Prior to the 2013 football season, I read the Virginia Tech peer-reviewed study entitled, "Brain Injury Prediction: Assessing the Combined Probability of Concussion Using Linear and Rotational Head Acceleration." This study was commissioned by the National Institute of Health and published in the May 2013 issue of Biomedical Engineering Society. This report concluded that a helmet that lowers acceleration predicts a lower incidence of concussion (10). I also read the independent laboratory impact test data on Unequal that showed in most cases a general reduction of acceleration (A) and a reduction in the NOCSAE® Severity Index levels.

Subsequently, I urged Liberty Christian High School to try Unequal. The school permitted its use provided that the parents consented, of which 25 parents approved and 35 parents of the varsity players declined. The 25 students with parental consent were provided Unequal for their football helmets. During the 2013 season, I witnessed the on-field performance difference of Unequal that showed a significant mitigation in the severity and rate of concussions as well as increased player confidence.

In 2013, there were seven (7) concussions, none of which had Unequal in their football helmets. Six of the seven players returned to playing football with Unequal in their helmets and none suffered any subsequent concussions. The seventh player did not have Unequal in his football helmet before or after his concussion he experienced later in the season.

During the season there were other noticeable improvements, including how non-concussed players felt less headache symptoms and/or the complete lack of headaches after practices and games, suggesting that Unequal may have also mitigated the effects of sub-concussive hits. I also observed the players with Unequal in their football helmets seemed to have a boost in confidence and what the players described as a 'mental edge.' They commented that impacts did not hurt their heads as much or at all, unlike before when they were resigned to football being a 'headache sport,' especially after games or practices.

Upon further investigation, I discovered there were other schools in Texas as well as schools in other states that had also experienced significant reductions in amount of concussions when using Unequal in their football helmets. Those results are detailed in *Table 1* herein.

V. **LIMITATIONS.** For purposes of this study, a concussion is defined as a type of traumatic brain injury (TBI) caused a by bump, blow, or jolt to the head. Concussions can also occur from a fall or a blow to the body that causes the head and brain to move quickly back and forth (2).

“Concussions are often referred to structurally as "diffuse axonal injuries" and result in some degree of functional impairment but differ from more moderate to severe TBI in that the impairment is transient in nature. Diffuse axonal injury, in addition to linear coup-contrecoup mechanisms of injury, can result in disruption to centers of the brain responsible for breathing, heart rate, and consciousness, but more typically result in memory loss, cognitive deficits, balance disturbances, and a host of other somatic symptoms,” according to research by Guskiewicz and Mihalik (5). Other concussion symptoms include: loss of consciousness, confusion, bruising, redness, dizziness, headache, nausea, pain, soreness, discoloration, numbness or tingling (5).

The Liberty Christian concussion rate was determined by reviewing the neurocognitive test scores as measured by the Immediate Post-Concussion Assessment and Cognitive Testing (ImPACT) neurocognitive test battery (verbal and visual memory), medical data from office visits and training staff notes.

“Helmets have a natural limitation,” said Dr. Julian Bailes, former NFL and NCAA team physician and chair of the Department of Neurosurgery at NorthShore University HealthSystem in Illinois. “With some major collisions, the helmet and the head stops moving. The brain, which is floating inside, can continue the momentum, hitting against the inside of the cranium possibly rotating and tearing fibers” (5).

“Helmets work well for preventing scalp laceration, skull fracture and bleeding in the brain, but they don’t always prevent rotation and tearing of brain fibers. The goal is to cut down on that movement that we call ‘slosh,’” Bailes said. Slosh is the term that describes the movement and tearing of the brain that occurs when an athlete sustains a hit and suffers from a concussion (5).

VI. RESULTS

1. *Liberty Christian High School*. As the team doctor, I am aware of the students' medical conditions, specifically concussions, leading into and during this season. The former head coach informed me there were 17 concussions among the football players during the 2012 season. In 2013, prior to the start of the season, I introduced Unequal to varsity team parents, of which 25 elected to have their kids use Unequal and 35 parents of the varsity players declined. Those players that used Unequal experienced zero (0) concussions and the remaining 35 players without Unequal experienced seven (7) concussions. Six of those concussed players experienced their concussions before the fourth game and returned to play according to accepted protocol, but this time with Unequal in their football helmets. These players sustained zero (0) concussions during the remainder of the season. The seventh player did not have Unequal in his football helmet before or after the concussion he had later in the season. The 2013 results are as follows:

Liberty Christian HS	**HELMETS WITH UNEQUAL**	**HELMETS NO UNEQUAL**
PLAYERS	25	35
CONCUSSIONS	0	7

2. *Newman Smith High School*. Because of the encouraging data, I inquired of other schools that had used Unequal in their football helmets to analyze their results. I learned of Newman Smith High School ("NS") in Carrollton, Texas, whose Head Coach/Athletic Trainer outfitted their entire varsity team with Unequal in 2013. According to him, there were six (6) concussions among the varsity football players during the 2012 season. He decided to implement Unequal for all of the varsity players in August 2013 and they used it during the entire 2013. Of the 55 players there were zero (0) concussions reported. Subsequently, for the 2014 season, the coach has decided to outfit both freshman and JV teams with Unequal as well. The 2013 Newman Smith High School results are:

Newman Smith HS	**HELMETS WITH UNEQUAL**	**HELMETS NO UNEQUAL**	
PLAYERS	55	0	(entire Varsity used Unequal)
CONCUSSIONS	0	0	

3. *Other High Schools*. Upon further inquiry, I learned of twelve (12) high schools in three other states and Canada, where, like at Liberty Christian, some parents had opted to have their kids use Unequal in 2013. Their survey data and that of Liberty Christian and Newman Smith are compiled and summarized in *Table 1* below. The results are impressive. Quantitatively, the 323 high school players that chose to use Unequal experienced less than a 1% concussion rate. The 836 players that did not use Unequal experienced more than a 9% concussion rate.

School Name	2013 - Helmets with Unequal		2013 - Helmets NO Unequal	
	# of Players	Concussions	# of Players	Concussions
1. Liberty Christian HS	25	0	35	7
2. Newman Smith HS	55	0	0	0
3. Bloomington Central HS	23	3	29	7
4. Centennial HS	30	0	40	5
5. Columbia HS	14	0	67	2
6. Harlem HS	40	0	84	12
7. Mar-Mac HS	17	0	31	1
8. Marengo HS	20	0	85	0
9. Normal West HS	15	0	117	12
10. Notre Dame HS	6	0	52	3
11. Rochester HS	29	0	86	3
12. Rock Falls HS	12	0	52	12
13. Sacred Heart-Griffin HS	26	0	54	4
14. Washington HS	11	0	104	11
Total	**323**	**3**	**836**	**79**

	2013 - Helmets with Unequal		2013 - Helmets NO Unequal	
	# of Players	Concussions	# of Players	Concussions
TOTAL	**323**	**3**	**836**	**79**
CONCUSSION RATE	**0.9%**		**9.4%**	
HIGH SCHOOL FOOTBALL PLAYERS	**1,159**			
HIGH SCHOOLS	**14**			

VII. DISCUSSION

In the 2013 season at Liberty Christian High School, 60 students played on the varsity team. There were 10 regular season games and three playoff games plus practices. After reviewing the neurocognitive test scores as measured by the Immediate Post-Concussion Assessment and Cognitive Testing (ImPACT) neurocognitive test battery (verbal and visual memory), medical data from office visits and training staff notes, we concluded there were a total of seven (7) concussions in the 2013 season, of which six (6) were treated and returned to play as per appropriate protocol, but first they were fitted with Unequal in their football helmet. No further concussions were reported for the remainder of the year by those six (6) players. Each of these players logged significant playing time and sustained a substantial number of impacts. The seventh athlete did not use Unequal before or after the concussion he experienced.

Additionally, I am not aware of any extended school loss or significant drops in grades during this season as we had seen in the prior seasons. We did have two players who suffered fractures from game injuries but neither was reported to have a concussion. One of them had a cervical six fracture and transient quadriplegia after a hit sustained on a special teams play. This player was hospitalized and treated with a cervical collar for three months. He recovered and just successfully completed track season.

The quarterback also took many hits during the season, including several significant contacts to the head with no reported concussions. During the pre-season game he suffered a fracture of the thoracic three transverse process. After seeing him sustain that horrific hit, I was relieved to learn he did not have a concussion. Upon examining him, I saw the student had Unequal in his football helmet. He told me his parents purchased it after I spoke to them at the preseason meeting, and he's used Unequal in his football helmet ever since. He was recently accepted to college with a Division I football program. This student's father told the college coach that he insisted Unequal be used in his son's football helmet. Now my own son, who plays on the eighth grade team, uses Unequal. He and our varsity quarterback have taken it upon themselves to proactively encourage their peers to use Unequal. As a sports medicine physician and a father, I enjoy seeing my son and others compete safely in the game they enjoy. In my medical practice, I recommend Unequal to parents of athletes suffering concussions to help mitigate the risk of additional concussions and increase their confidence upon returning to the game.

Figure 1. Unequal GYRO® front view

Figure 2. GYRO back view

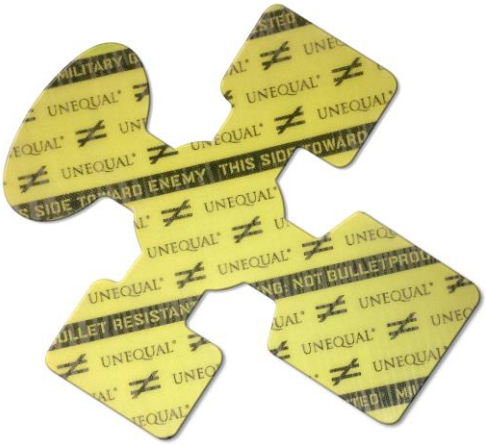

Figure 3. GYRO in football helmet

Figure 4. Place-N-Play GYRO in helmet

VIII. ACCELERATION: KEY VARIABLE IN PREDICTING CONCUSSIONS

It is now understood that one of the major, if not the major, predictors of the risk of concussion is acceleration (A) - the force with which the brain, responding to instant impact to the skull, hits the interior of the skull. This has been established by major studies including one from the Virginia Tech School of Biomedical Engineering and Sciences (10), funded by the National Institute of Health, peer reviewed and published in the Annals of Biomedical Engineering. They conclude that reducing the acceleration experienced by the brain as a result of impact to the skull (or a helmet covering the skull) represents a way to reduce - although not entirely eliminate - the risk of concussion.

"Linear and rotational head accelerations are hypothesized to be the primary risk factors for concussion during an impact. Both direct and inertial (*i.e.*, whiplash) loading of the head may result in linear and rotational head acceleration. Head acceleration induces strain patterns in brain tissue, which may cause injury," according to research by Guskiewicz and Mihalik (5). They further conclude, "Sport-related concussion typically results from forces directly imparted to the head or indirectly through the neck, resulting in a combination of rapid acceleration and deceleration. Such forces create linear and/or rotational acceleration/deceleration on the brain." (5) Other variables include sub-concussive blows and slosh (the movement and tearing of the brain that occurs when an athlete sustains a hit and suffers from a concussion).

Unequal was tested for its acceleration reduction properties at Intertek, Inc., an ISO17025 accredited and independent impact testing laboratory. Intertek® tested, among other things, adult and youth football helmets with and without the inclusion of Unequal. Testing was done using approved head forms to standards enforced by the National Operating Committee on Standards for Athletic Equipment (NOCSAE®) (9), for which such tests are to be done by an accredited testing laboratory (Intertek) approved for conducting such tests to NOCSAE standards. Impact zones included the front boss, front, right side, rear boss, rear, top and left side of each football helmet. In most cases, the testing generally reflected that both the severity index and peak acceleration of the football helmet with Unequal was lower than that of the helmet alone. The tests generally indicated Unequal can significantly reduce acceleration in most cases. The reason for Unequal's superior performance could be attributed to its patented military grade composite formulated with Kevlar®, Accelleron® and ImpacShield®.

Rowson and Duma state that "A helmet that has lower accelerations associated with each drop test will therefore predict a lower incidence of concussions" (10). Drs. Bailes and Maroon concur. Dr. Joseph Maroon, MD., Professor and Vice Chairman of the Department of Neurological Surgery and Heindel Scholar in Neuroscence at the University of Pittsburgh Medical Center, and co-developer of ImPACT™ concussion testing, links reduction of acceleration in helmets to Unequal. Dr. Maroon states, "In my professional opinion, Unequal's reduction of acceleration, as reflected in the tests performed by Intertek, predicts a significant reduction in the risk of concussion as compared to the use of Riddell adult and youth helmets alone. Moreover, I believe that the results of the Intertek testing on other types of helmets equipped with Unequal can be extrapolated into a finding that the use of Unequal padding in hockey, lacrosse, snowboard, equestrian, skateboard, baseball and bicycle helmets might improve protection beyond that found by use of the helmet alone, thus predicting a significant reduction in the risk of concussion in those applications as well" (8).

Dr. Bailes stated, "Based on this Virginia Tech study and other reports, laboratory studies throughout the years, and my research and experience, I concur that acceleration is one of the major predictors of TBI, such as concussion. TBI can occur as a consequence of a focal impact upon the head, by a sudden acceleration/deceleration of the brain within the cranium, or by a complex combination of both movement and sudden impact. Therefore, devices such as helmets and supplemental head padding are viable solutions to reduce, although not eliminate, the risk of concussion. I believe the use of Unequal enhances the reduction of acceleration based on my experience with the product and athletes who have used it, survey studies of users, and certified test reports from Intertek" (1).

"The testing reflected that both the severity index and peak acceleration of the helmet with the Unequal included was generally lower than that with the helmet alone. The tests validate that the Unequal could considerably improve the results on acceleration reduction which should materially reduce the risk of concussion. In my view, a helmet equipped with Unequal indicated a measurable reduction in the biophysical forces which translates to a risk of concussion, as compared to a helmet without Unequal," states Dr. Bailes (1).

IX. CONCLUSION

The concussion rates resulting from the 1,159 player sample size are impressive. 14 high schools participated. They included Liberty Christian, Newman Smith and the 12 high schools from four states and Canada. The students used various types and styles of football helmets manufactured by Schutt®, Riddell® and Xenith®. Quantitatively, the 323 high school players that chose to use Unequal experienced less than a 1% concussion rate. The 836 players that did not use Unequal experienced more than a 9% concussion rate.

An unanticipated benefit of Unequal was that players seem to have a boost in confidence and what they described as a 'mental edge.' They commented that impacts did not hurt their heads as much or at all, unlike before when they were resigned to football being a 'headache sport,' especially after games or practices.

After evaluating the Virginia Tech study, Intertek impact tests, 1,159 player results, ImPACT neurocognitive data and my personal experience with Unequal, I concur with Drs. Bailes and Maroon that football helmets with Unequal predict a significantly lower risk of concussions.

X. RECOMMENDATION

I recommend that scholastic institutions at all levels, leagues, professionals, neurological and medical advisory boards evaluate the benefits of Unequal for at-risk players and those wanting to help mitigate their risk of concussions. I respectfully submit this paper to continue the study of Unequal and its significant effect on its reduction of concussion risk.

XI. ACKNOWLEDGEMENTS

I wish to extend a special thanks to the staff at Liberty Christian, especially Michele Richardson, Assistant to the Athletic Director, and Taran Sharpe - ATC, whose efforts were paramount in obtaining the data for this study. I would also like to thank the coaching staff at Liberty Christian, Newman Smith and the other twelve schools that encouraged and facilitated these player surveys and critical data.

Respectfully submitted,

Chad B. Stephens, D.O.

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