



Riding SMART!

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President's News & Views

SPECIAL EDITION

Neck injury, neck pain and preventative measures

It certainly seems to me that the summer has flown by. I haven't ridden as much this summer as I normally do, however my spouse and I do have a 12-15-day tour of eastern state civil war sites planned for late September/early October, which we are looking forward to.

Board President Rich Henrion has certainly taken up my slack. Since retiring from 39 years of teaching Auto Technology in June of 2015, Rich launched a new phase in his riding career. In the summer of 2016, he logged nearly 25,000 miles on his BMW R1200 RT, riding from his home in Norway, MI to such locations as Hudson Bay and northern California. In 2017 he surpassed his 2016 riding mileage on the same BMW, including a ride to Yellowknife in the Northwest Territories. This summer, Rich has ridden 35,000 miles before the Labor Day weekend, including a ride to and across Newfoundland. He has another 10,000 on his schedule before the end of this riding season. His goal is to put 100,000 miles on his R1200RT in four years. Rich's extensive on-road riding experience, plus his thirty-five years as an MSF RiderCoach Trainer, makes him a valuable representative of SMARTER. We tap into Rich's extensive long-distance riding experience to learn his advice on how to avoid neck pain, and other pains and discomforts, while riding.

Every edition of *Riding Smart* is designed to share important information surrounding topics relevant to skilled, responsible, trained and educated riders. Special editions also work as a tool to help focus on a portion of our mission of gathering, analyzing and sharing motorcyclist safety research. A complete special edition becomes a valuable education document for posting on our web site, which we are planning to do with this edition.

As always, the SMARTER Board encourages each of you to read, analyze and evaluate the information in our newsletter, share it with others and contact us if you have any questions or concerns.

Dan

Riding Smart Preview

Neck injuries and motorcycle helmets _____	2-3
Neck Pain _____	3-4
Rich's advice _____	5
Neck Braces _____	5-7
What about the hump? _____	7
Airbag vests and jackets _____	8-9

Neck injury and motorcycle helmets in the event of a crash

A common objection to helmet use is the fear that any benefit in preventing brain/head injuries may be offset by increased risk of neck injury. This objection is not supported by the research and was a factor in SMARTER's decision to dedicate a specific section on our web site to the research related to helmet use and spinal injuries - <http://smarter-usa.org/research/helmets-laws/spine-injury/>.

Numerous studies have looked at the possible role of motorcycle helmets causing neck injury among motorcyclists in the event of a crash. The issue is certainly not straight forward.

To read summaries of ten “helmet and neck injury” research studies and to access abstracts or published reports visit:

<http://smarter-usa.org/research/helmets-laws/spine-injury/>

Helmets for Preventing Injury in Motorcycle Riders (2009) is a literature review of the effects of motorcycle helmet use on fatality, head injury, and neck injury. Sixteen studies that met quality standards and used neck injury as an outcome were identified. The authors reported that the data could not support any conclusion about the possible association between helmet use and the occurrence of neck injury.

A 2011 study titled *Relationship between Cervical Spine Injury and Helmet Use in Motorcycle Road Crashes* found that in frontal collisions, the use of helmets significantly reduces the severity of cervical spine injury, whereas in rear-end, side impact, and skidded accidents, the use of helmets increases the probability of a severe cervical spine injury. However, in the latter crash modes, a motorcyclist without a helmet will have to trade-off with head injury.

We know there is overwhelming evidence that motorcycle helmets protect against head and brain injuries in the event of a crash. A small number of studies have also reported a positive association between motorcycle helmet use and neck injury. *Motorcycle Helmets and Cervical Spine Injuries: a 5-year Experience at a Level 1 Trauma Center* published in 2018 found that helmeted motorcyclists demonstrated a significantly lower likelihood of sustaining a cervical spine injury and additionally that unhelmeted riders demonstrated a proportionally higher number of cervical vertebrae fractures. *Motorcycle Helmets Associated with Lower Risk of Cervical Spine Injury: Debunking the Myth* published 2011 found that helmeted motorcyclists are less likely to suffer a cervical spine injury after a motorcycle collision compared to unhelmeted motorcyclists. The authors report their findings “debunk a myth” and challenge a long-standing objection to mandatory helmet use that claims helmets cause cervical spine injury.

So where did this myth that helmets cause neck injury originate? The fear that any benefit in preventing brain/head injuries may be offset by increased neck injuries, is rooted in the 1986 Goldstein study (*The Effect of Motorcycle Helmet Use on the Probability of Fatality and the Severity of Head and Neck Injuries: A Latent Variable Framework*) which concluded that past a critical impact speed to the helmet of 13 mph, helmet use reduces the severity of head injuries at the expense of increasing the severity of neck injuries. The Goldstein results were adopted by the anti-helmet community to justify resistance to compulsory motorcycle helmet use. Despite literature reviews that find no evidence of an association between helmet use and neck injuries, and the studies that report helmet use decreases the likelihood of neck injury, state motorcyclist rights organizations still reference the old Goldstein research as support for their cause.

While the studies referenced above might be enough to convince someone who looks at the research in total that helmets do not cause neck injuries in the event of a crash, damning evidence regarding Goldstein's conclusion was revealed in the 2016 study *Motorcycle Helmet Use and the Risk of Head, Neck, and Fatal Injury: Revisiting the Hurt Study*.

First it is important to know that Goldstein did not conduct a crash injury outcome

Continued to page 3

Continued from page 2

study of his own. He obtained the final data sets from the Hurt Study (<http://smarter-usa.org/research/crash-causation/>) and applied statistical models to the Hurt Study data to draw his conclusions.

The authors of *Motorcycle Helmet Use and the Risk of Head, Neck, and Fatal Injury: Revisiting the Hurt Study* (including James V. Ouellet who was a member of the original Hurt Study team) replicated the 1986 Goldstein study to understand how he obtained his unexpected results, and then applied modern statistical methods to estimate the association of motorcycle helmet use with head injury, fatal injury, and neck injury among collision-involved motorcyclists.

The authors found Goldstein's analysis to be critically flawed due to improper data imputation, modeling of extremely sparse data, misinterpretation of model coefficients and that Goldstein actually fabricated values for a variable that was missing for 97.7% of the riders. He also used an invalid method of summarizing overall neck injury severity, and he misinterpreted his model results. This new analysis showed that motorcycle helmets were associated with markedly lower risk of head injury and fatal injury and with a moderately lower, but statistically significant, risk of neck injury.

It seems clear that the four decades of wrong information that has been disseminated by individuals and organizations opposed to helmet laws has resulted in some motorcycle riders choosing to wear a novelty helmet or go helmetless if allowed. That result is truly a motorcyclist safety tragedy.

While the available research does not seem to eliminate all negative association between helmet use and neck injury, the bulk of evidence indicates that helmet use either decreases or has no influence on the likelihood of suffering a neck injury if you are in a crash.

Neck pain and wearing a motorcycle helmet

Let's get to the bottom line right at the start. Most experts agree that neck pain during or after riding is not due to the weight of the helmet. SMARTER did not find much in the way of real research on this subject; however we did locate one review of the literature published between 1980 and 2006 (<https://www.sciencedirect.com/science/article/pii/S0161475408003370>) which concluded

- Neck pain is common
- Nonmodifiable risk factors for neck pain included age, gender, and genetics
- Modifiable factors included smoking, exposure to tobacco, and psychological health
- Disc degeneration was not identified as a risk factor and
- The use of sporting gear (helmets, face shields) to prevent other types of injury was not associated with increased neck injuries in bicycling, hockey, or skiing.



Expert opinion regarding the subject is easy to locate with a simple web search. An example of an expert opinion can be found at: <http://www.doctorschierling.com/blog/motorcycle-helmets-and-chronic-neck-pain>

Continued to page 4

Continued from page 3



Neck pain is one of all the other possible pains we might experience after a long ride such as lower back pain, pains in the upper back and shoulders, numbness or pain in legs, numbness in hands or fingers or general fatigue.

Neck pain is generally due to:

1. weak neck and upper back muscles or
2. poor posture and tension while riding (including grinding your teeth).

These two issues are, therefore, the areas to target to alleviate the neck pain.

Pain due to weak muscles

First, if you are coping with neck pain on a day-to-day basis even when not riding, seeking medical advice should be your first step. If your neck pain comes only after riding, consider learning simple neck and shoulder stretching exercises and practice at least twice daily. When the pain is gone, start strengthening exercises. Ride more with the helmet on. This should work well for most riders where muscle weakness is the cause of the neck pain.

Pain due to poor posture

Poor riding posture and tension while riding can also be a contributor to neck pain while or after riding. Proper posture will vary with the type of bike and each type has its pros and cons. In all cases you should use your 'core muscles' to hold yourself in place, rather than using the handlebars to keep you in position. Ride with a balanced and relaxed body position and regardless of the type of motorcycle you ride, make adjustment to the bars, levers, seat height and foot rests to the extent possible to fit your size. When riding, remind yourself to relax your shoulders, arms and neck (while keeping your eyes and mind sharply focused on the task). A good neutral riding position starts with the head and goes all the way to your feet. Check in occasionally with your body position to make sure you haven't drifted back into bad habits.

We won't review the elements of proper riding position/posture here as we know SMARTER members are experienced and trained riders. If you want a refresher, just do a web search – there is a great deal of information available.

Most importantly know that your helmet is not the root cause of the neck pain and it could be a lifesaver in the event of a crash.



The CDC found that 22% of most common motorcycle crash injuries occurred to the **head and neck**

Rich's advice . . .

As noted in Dan's President's News and Views, I rode more than 28,000 miles during the summer of 2017 and have ridden 35,000 so far this summer. I am a regular participant in long-distance riding events having participated in thirty (30) 1,000 mile Saddle Sore Iron Butt rides. I can't even venture a guess about how many times I have ridden more than 600 miles in a day. Six hundred miles in a day is a normal day for me.



Obviously in order to ride long distances in a single day and long distances over multiple days, a rider needs to be comfortable. My number one piece of advice is to make adjustments to the bike to ensure it fits you. I am a big guy – 6'7" and around 240 lbs. – so very few bikes fit me as they come from the factory. I regularly add an extra tall windshield and custom designed seat. I adjust the bars and levers, add forward mounted footrests and lower the stock footrests as appropriate. Making alterations to the machine so the bike fits you and your riding style is my first piece of advice for avoiding pains.

Number two is to stay hydrated. Heat cramps in your legs and stomach are a common initial symptom of dehydration. Studies have shown that surprisingly low fluid losses can significantly affect you. The key point to remember is not to wait until you're thirsty but to drink a little and drink often right from the start of your ride. I use a hydration system (like a CamelBak) and my goal is to take 3-5 good sized sips every 10-15 minutes right from the moment I begin riding. I make myself drink a 1-liter water pouch every tank of fuel, which is usually 230 to 250 miles. My breakfast is light but includes lots of fluids and a banana to provide a source for extra potassium, which aids in preventing cramps. And no caffeine in the morning. I also have my own preferences for a recovery drink at the end of a long ride. No matter how careful you've been with your hydration, especially on a hot day, you're likely to be dehydrated and, as well as providing the protein and carbohydrate to kick start your recovery, the fluids and electrolytes that a recovery drink provides are essential. And no alcohol in the evenings.

Quality and proper fitting gear is very important. In addition to the usual full gear, I also wear a Koolbak brand kidney belt which helps me maintain a proper riding posture, an important element for avoiding the various pains that riders often experience.

Knowing your body and your bike and being prepared goes a long way in helping make every day rides a true pleasure.

Neck brace – should I use one?



A neck injury from any cause is potentially life threatening and certainly has the possibility to be life alternating. The research tells us that both helmeted and unhelmeted motorcyclists involved in fatal motorcycle collisions show a high frequency of difficult to detect neck injuries (*Head and Neck Injuries in Fatal Motorcycle Collisions as Determined by Detailed Autopsy, 2003*). Motocross riders have been using neck braces for more than a decade to help prevent neck injury in a crash. In this article, we investigate the question of the benefit of adding a neck brace to your street riding gear.

Continued from page 5

There is too little direct information and too many “it depends” situations for us to conclude “yes” or “no” to our title question. What we will do here is provide members with information and hopefully open up the topic for more discussion.

Every member certainly knows SMARTER’s position on full gear but does that position include a neck brace? Should neck protection be on our (and your) list of full gear for street riding or are neck braces only necessary for those into serious off-road riding.

The history

In the early 2000s, South African doctor and motorcyclist Chris Leatt’s son was involved in off-road riding. During that time, Dr. Leatt apparently witnessed the death of a rider. Wanting to help protect his son and other young riders, Leatt began to develop a neck brace designed to protect motorcyclists from injury. His first brace, marketed in 2004, was designed to provide cervical protection specifically for off-road riders. Since that time, neck braces have become a standard part of full gear for motocross and off-road racers, common for hard core off-road riders and are also now widely used by adventure and dual sport riders (<https://www.leatt.com/>).



Leatt STX Road Neck Brace

<https://www.leatt.com/shop/moto/neck-braces/stx-road-888.html>

Read a September 3, 2018 review of the Leatt brace by Ken Condon at:
<http://www.ridinginthezone.com/product-review-leatt-stx-rr-neck-brace/>

There are now a wide range of braces and armor with integral braces from many of the popular motorcycle gear brands.

How a neck brace works

A neck brace is designed to protect the neck in the event of a crash. While the actual designs from different manufacturers are somewhat varied, they all are intended to protect by limiting the movement of the head and neck during a crash and redirecting the consequences of the impact onto the shoulders or chest. Clearly any brace cannot entirely prevent injuries, but regardless of the manufacturer or specific design, they are all envisioned to reduce the likelihood of severe neck injuries in the event of a crash.

The available research

Although neck braces have been in use since the early 2000’s, there is still a lack of clear empirical data regarding their effectiveness. Researchers cannot get one group of riders to wear a brace and another group to go without a brace and have both groups crash on their heads in the same manner and then compare the neck injury results. Research using simulated models has been conducted by Deepak Sathyanarayan as part of his doctoral degree work at the University of Virginia and published as a symposium paper titled *The Efficacy of a Motocross Neck Brace in Reducing Injury* (<http://smarter-usa.org/wp-content/uploads/2018/09/The-Efficacy-of-a-Motocross-Neck-Brace-in-Reducing-Injury.pdf>).

Continued to page 7

Continued from page 6

His findings indicate an insignificant reduction in injury risk with the use of a neck brace, that the reduction is connected to the standoff between the helmet and the brace, that reducing the standoff showed moderate decreases in injury risk in most impact cases relative to the no brace. However, there results loading to the shoulder that reduces any benefit of a fully engaged neck brace.

The web is full of anecdotal information from riders who sustained serious neck injuries without braces and wished they had been wearing one, including this from a doctor whose recommendation is “If you ride a motorcycle in any shape or form, you should be wearing a Leatt neck brace. Period.” (<http://www.greatamericantrek.com/wear-leatt-neck-brace/>)

Reading this carefully, however, makes one wonder if it is just a disguised advertisement for Leatt. Here is another link for more balanced discussion: https://www.reddit.com/r/MTB/comments/2ikfeb/the_epistemology_and_efficacy_of_neck_braces/

Some pros and cons

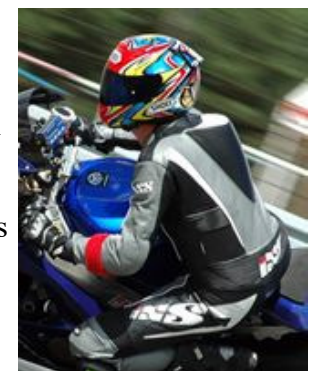
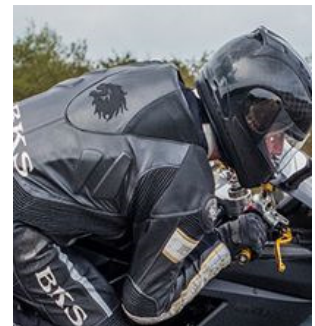
Every neck brace available is designed to offer increased protection in the event of a crash while still being comfortable to wear and not impede movement or vision. A neck brace protects by limiting the movement of your helmeted head in the event of a crash. The brace restricts forward and backward and side to side movement, preventing hyperextension of the neck and transfers the impact onto the brace and into the shoulders rather than the neck. Some braces are made to be adjustable regarding how far your head can move before contacting the brace.

But like helmets and other gear, a neck brace will have limitations to their effectiveness depending on the type of crash you have. No matter what design or manufacturer, no neck brace can prevent all neck injuries. In this matter neck braces have been compared to knee braces – designed to prevent an injury but can't prevent all injuries. Also, it is possible that a neck brace could increase the risk of collarbone injuries. The big difference is that a collarbone injury is not likely life threatening and you can probably recover.

What about the hump?

During our research for this neck injury special edition, we encountered blog posts regarding the hump on the upper back of some racing leather suits. In answer to the question “what is the hump for?”, we found answers which stated the hump is designed to minimize injury in case of a crash by stopping the rider's head from snapping backwards because the lower edge of the rider's helmet will come up against the upper edge of the hump, thereby preventing a whiplash type neck injury. This answer was however rare and seemingly incorrect.

It is more likely the hump was initially designed for aerodynamic purposes – smoothing out the airflow coming off the top and back of the rider's helmet when they are tucked in. In addition to the aerodynamic purpose, the hump may hold a fluid bladder to enable the riders to drink during the race. More recently the hump may also house the electronics for airbag suits. It doesn't seem a hump was ever designed as a neck injury prevention device.



Airbag vests and jackets

The hump apparently was not designed for protection but now serves as a place to house the electronics for airbag suits. The Grand Prix motorcycle racing commission has decided that for 2018 all riders will have to use leathers equipped with an approved airbag system. Some reasoned that with airbag systems now an accessory that is available to all riders, it was high time that at the highest level of motorcycle racing the riders should be required to use such protective equipment. One could easily argue the opposite – if at the highest level of motorcycle racing, riders are required to use an airbag system, doesn't it make sense that everyday riders could reduce the likelihood of injury in the event of a crash by wearing an inflatable vest or jacket?



Motorcyclist safety countermeasures are often divided into active and passive measures. Active safety systems measures are designed to prevent a crash from happening. Passive safety systems are those that take effect during, or immediately after, a crash in order to minimize injury to the rider. A passive motorcyclist specific innovation is inflatable airbag jackets that deploy when the rider is ejected from the machine, cushioning the rider from impact. Airbag vests and jackets are designed to protect the neck, spine, and major organs in the torso.

An excellent overview of how these vests and jackets work, a history of the development of the systems and a comprehensive Q & A can be found at: http://www.airbagjacket.eu/airbag_jacket_history.html. An excellent Q & A, as well as a review of three top brands, is here: <https://watchyourselves.com/best-motorcycle-airbag-vest-jacket-reviews/#tab-con-10>. A nice explanatory video is here: <https://www.youtube.com/watch?v=MWQbMfx8rOU>



Like neck braces, there is little in the way of independent comprehensive testing of inflatable vests and jackets with most information coming from rider experience and opinion or from the manufacturers. We did, however, find one study where the effectiveness of an airbag device fitted in the biker's garments was verified through various numerical simulations - *Design and numerical evaluation of an airbag-jacket for motorcyclists, 2010* at: <http://smarter-usa.org/wp-content/uploads/2018/09/The-Efficacy-of-a-Motocross-Neck-Brace-in-Reducing-Injury.pdf>

In Summary:

Neck brace vs. airbag vest or jacket

Neck braces and airbag systems are both designed to prevent or reduce injury in the event of a crash. There is little in the way of independent research for the effectiveness of either, but there is significant manufacturer and user information indicating that both do the job they are designed to do. Neck braces seem to lean to those who ride off-road or adventure touring and vests and jackets more for on-road riders. Neck braces range in cost from as low as \$40 to about \$260.00. Inflatable vests and jackets range from a low of about \$150 to as much as \$1,000.00.

In the United States it seems only eye protection and helmets are sometimes required by law, leaving everything else up to the rider's choice. Certainly, SMARTER members understand the importance of wearing "all the gear, every time you ride." But should "all the gear" include a neck brace or an inflatable vest or jacket? The answer to that question depends - certainly on the type of riding you most often do, but also on your assessment of the pros and cons of each and your personal attitude regarding risk.

SMARTER has a public Facebook Group:

<https://www.facebook.com/groups/192085967504606/>



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