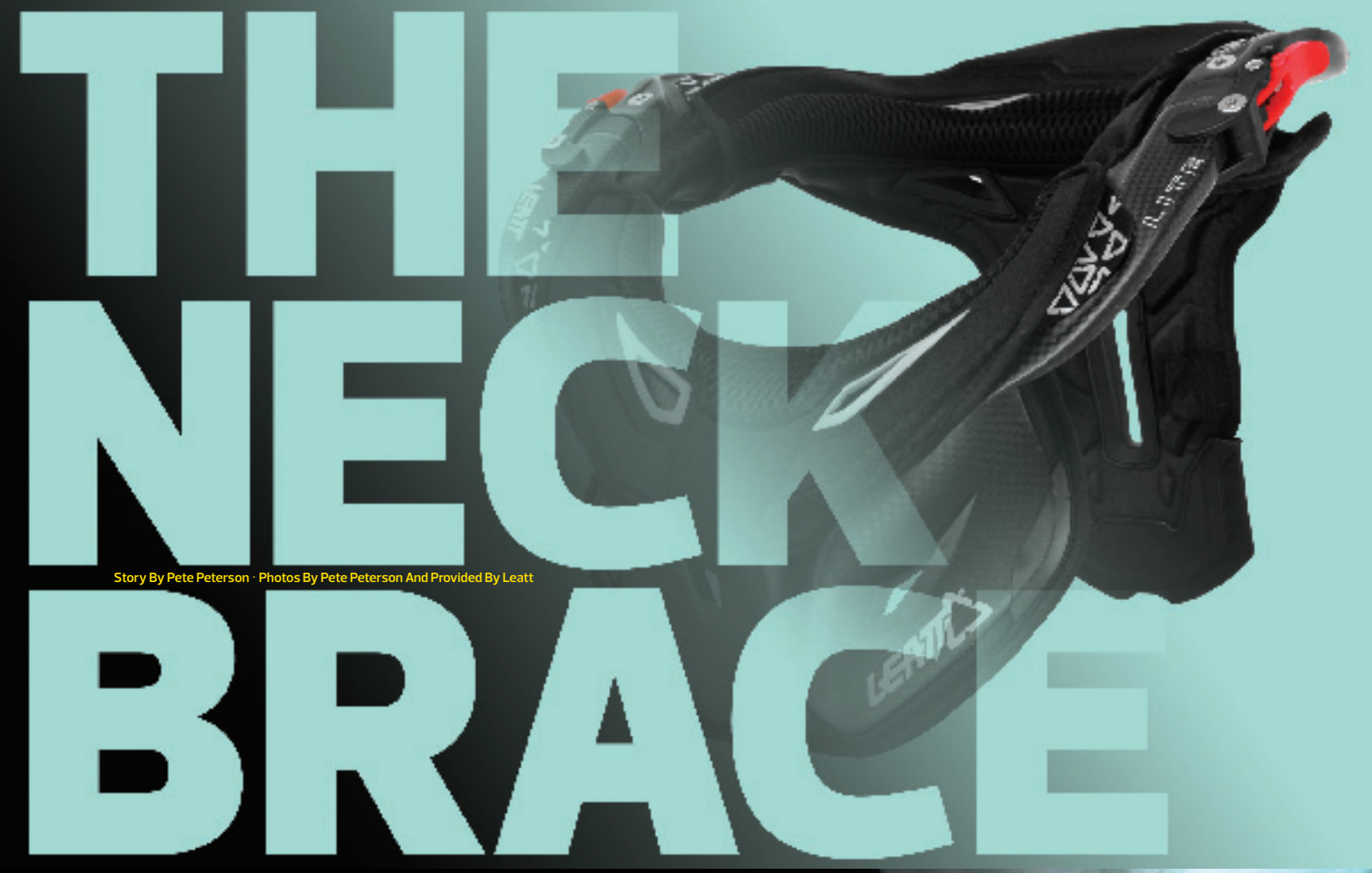
THE NECK BRACE



Story By Pete Peterson · Photos By Pete Peterson And Provided By Leatt

SHOULD YOU WEAR ONE?

Editor's Note: Dirt Rider *made every effort to thoroughly research this topic and supply you, our loyal reader, with pure facts and raw data. We present this information not for controversy but for clarification in order to help you make an informed personal determination about whether or not to utilize a neck brace. Ride at your own risk, wear proper safety gear and remember: Motorcycles are fun, and with advancements in safety technology riders are better protected than ever before.*

Motorcycle riding is thrilling, and if you're holding this magazine, it's likely something you love to do. But the sport can also be dangerous, and you should have a good understanding of the protective equipment available. This magazine story might be unpleasant, will border on gruesome and may force you to consider thoughts you normally might avoid. However, it is intended to deliver information so that you can answer for yourself the long-standing question: "Should I wear a neck brace?"

The genesis for this story was a visit to the Leatt laboratory in Cape Town, South Africa, where I met Dr. Chris Leatt, biomedical engineers Cornel de Jongh and Pieter Keevy, several others from the Leatt team, and toured the company's test and design lab. This story is composed primarily from information provided by Leatt since they have a full-time test/development lab. Several facts and statistics will contain endnotes, and this story's website component will cite those references as well as offer more information and opinions on what you read here (that story's found at www.dirtrider.com/2013neckbraceextras.com). This story is not designed to endorse the Leatt brace over other brands' braces. Let this be a start, not an end point, to your (and our) investigation into neck protection.

THE NECK BRACE

SPINAL CORD INJURY VS. SPINE INJURY

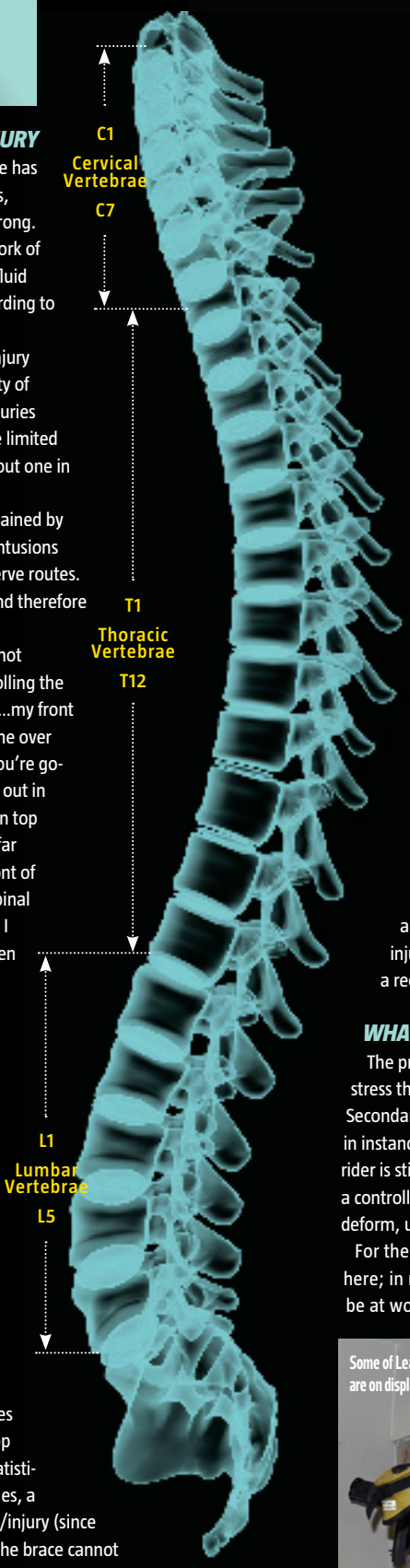
First, some structural information: The spine has 24 articulating vertebrae supported by discs, ligaments, ribs and muscles. The spine is strong. In contrast, the spinal cord is a fragile network of nerve fibers, nerve cells and cerebrospinal fluid that together have the consistency of, according to Dr. Leatt, "toothpaste in a plastic bag."

Spine injury is different than spinal cord injury (SCI). In fact, it seems likely that the majority of spine injuries do not result in spinal cord injuries [1]. A good guess by Dr. Leatt, based on the limited statistics available today, would be that about one in five spine injuries result in SCI [2].

SCI can occur without spine injury. As explained by Dr. Leatt, "Over-bending can cause cord contusions (famously Jimmy Button) or avulsions of nerve routes. The brace limits movement [of the neck] and therefore the potential for these injury types."

In 2000, supercross racer Jimmy Button, not wearing a neck brace, crashed in practice rolling the whoops. He described his crash to me as, "...my front end just tucked in one [whoop], it flipped me over the bars, it was kind of like one of those, 'you're going so slowly that you don't put your hands out in front of you,' and I just, like, got my head on top of one of the whoops, it bent my head too far back, and it ripped the ligaments off the front of my spine in my neck and just pinched my spinal cord, and I went cold and numb the second I hit the ground...." When I asked if it has been studied if a neck brace might have helped, Button replied, "It hasn't been analyzed, but in knowing the crash that I had, and knowing, because I was conscious the whole time, how I hit the ground, what actually happened to me—had I had a Leatt on, I would have probably gotten up with a headache, and that's it."

Another interesting statistic I looked into was that some studies put the majority of motorcycle SCI in the thoracic (middle) section of the spine (most of these statistics are from before neck braces were even on the market) [3]. The analogy used by Leatt to explain this is to think of bending a small twig. The point of maximum bend is in the middle. Neck braces are designed to only protect the cervical (top seven vertebrae) section of the spine, so statistically, in most SCI-inducing motorcycle crashes, a neck brace might not help prevent damage/injury (since the injury is most likely to occur in an area the brace cannot protect). In contrast to all this, two of the emergency physicians I spoke with would put the majority of SCI not at the center, but at the neck and the thoracic/lumbar transition. Keep in mind these doctors are seeing all sorts of injuries (car, workplace, high falls, etc.). A spinal cord injury researcher I spoke with also had the opinion that the neck is most vulnerable since it is the least protected and the head can act as a lever on it.

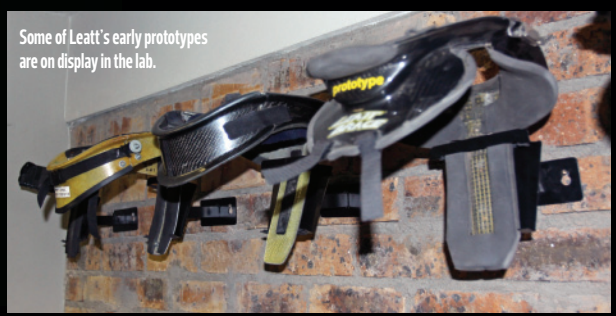


Dr. John Bodnar, known fondly as "Doc Bodnar," is on the front lines at pro racing events, and he offered an informed opinion on the subject of safety. "Spinal injuries have been a major concern not only in the supercross and motocross series, but for anyone who rides a motorcycle. For the professional race series, the Asterisk Mobile Medical Center has been collecting data over the last two years in regards to spinal injuries and the use of neck braces. Since the overall number of injuries is relatively small, it will be several years before any statistically significant change can be shown and validated. However, at this point, we have seen a trend toward a decrease in cervical spinal [neck] injuries with use of neck braces and no increase in clavicle [collarbone] or thoracic [middle spine] injuries. We can only hope that this trend continues and we can see a reduction in the number and severity of spinal injuries."

WHAT A BRACE IS

The premise of a neck brace is to redirect some of the forces that would stress the neck through alternate load paths into other areas of the body. Secondarily, a neck brace could limit extreme ranges of motion of the neck in instances when the neck is injured, SCI has not yet occurred, but the rider is still mid-crash. A good neck brace should be able to slow the head in a controlled manner, and have failure points where the brace will break or deform, under extreme forces, so that it cannot cause damage to the rider.

For the sake of explanation, these forces are discussed individually here; in real-world incidents a combination of these forces would likely be at work.



Some of Leatt's early prototypes are on display in the lab.

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AXIAL LOADING

Injury: This is a force that pulls or pushes on the spine, such as in the case of crashing headfirst into the face of an upcoming obstacle and pushing force straight down on the top of the head. This is known as pure axial loading. Vertebrae disruption occurs in the form of a burst fracture (one or more vertebrae shattering partially or completely). According to Dr. Leatt, the burst fracture would occur before any of the current motorcycle neck braces' effects come into play. Alpinestars was also very helpful with this story, and their experts agree with this comment.

Possible Benefit: This is the type of crash a neck brace is least effective against [see notes below]. By the time the helmet contacts the brace, spinal damage can have occurred. But the damage might not be over with, and at that point in the crash a brace could help by redirecting force away from this "injury in progress," and limiting extreme movements of the injured spine.

Note: It should be noted that according to Dr. Leatt, "The initial helmet movement and escape from the impact load prior to contacting the brace is important to prevent axial neck loading and injury." You wouldn't want to completely restrain a rider's neck even if you could, because if a person's neck had no movement and the person were to be dropped from less than one meter straight onto his head, that force could result in catastrophic neck injury.

Note: Alpinestars believes that the most significant and likely cause of catastrophic neck injury is axial loading, and provided this statement regarding axial loading, "The damage is caused between five and eight milliseconds of the initial head impact, and [damage] is especially likely when the impact occurs within the cone of vulnerability. In the course of the research that Alpinestars undertook, the 'Cone of Vulnerability' defines a virtual space starting from the top of C1 and extending upwards at a 15-degree angle through to the top of the head. If the impact occurs within this cone-shaped space with the rider's torso following, the load is transferred almost instantaneously and very directly to the neck. Inside this time period the head does not move at all and therefore is not in contact with the support surface, so no alternative load path exists."

HYPEREXTENSION AND HYPERFLEXION

Injury: This is when the head is knocked toward the torso in one direction (forward, back or side), as was the case in Jimmy Button's crash.

Possible Benefit: According to Dr. Leatt, "A combination of forces are usually at play during an impact sequence and includes coupled-axial load, shear force and torque (bending moments). Hyperflexion or hyperextension are two common injury mechanisms for SCI, whereas rotation is unlikely in motorcycle accidents (and only significant when combined with sideways flexion [lateral]). Please remember, though, that a pure flexion injury without axial compression is unlikely. The brace is not effective in preventing the initial pure compression-type injury, but is effective later as a coupled flexion/compression or extension/compression load-reducing mechanism."

Trey Canard had a major supercross crash in 2012 when he doubled a triple jump and was landed on by Ryan Morais. Canard was wearing a Leatt brace. Regarding the doctors' comments on the brace, Trey said, "Everyone has been 100 percent supportive of it, of the fact that [the brace] was, they feel very strongly, the reason I had no neck trauma. I had no neck trouble at all, which was pretty amazing [because another rider] landed right on my head. I think the brace did its job."

Note: Whiplash, although possible in a motorcycle accident, is more common in restrained torso events like automobile accidents.

BRAIN INJURY

Injury: Brain injury occurs from the brain's impact with the inside of the skull, which can be "out of sync" with the skull's impact with the ground.

Possible Benefit: I talked with Dr. Terry Smith of Dynamic Research Inc. (which conducted some testing with Atlas for their brace), and he told me about some new research, independent of the Atlas testing, that he is doing with Mr. Dave Halstead of Southern Impact Research Center in Tennessee. They have been doing helmet impact tests and finite element brain modeling that looks at how the brain tissue behaves during different kinds of impacts. Their research shows that there is evidence that the risk of brain injury is increased when the head is already in rotation (relative to the torso) when it hits the ground. Since the brain is suspended (not solidly attached) within the skull, it lags behind the skull during sudden movements. Theoretically if a rider is bucked or thrown violently, a neck brace could slow the head rotation before the head impact (so that the magnitude of total brain motion is decreased), then it could potentially reduce or prevent brain injury. This is not something neck braces are designed to do or claim to do, but it is something worth looking into.

DAVID BAILEY

David Bailey made a video encouraging neck brace use back in 2007. It seemed that's when neck brace use really took off. I asked him for a comment today.

"I'd like to start by asking where all the proof is that knee braces and wrist braces work? I don't understand why most riders accept those, but question neck protection and demand proof. Riders wear knee braces no questions asked knowing that they have a propensity to snap femurs and tib fibs! There are also more knee injuries in the sport today than I can ever remember, so besides not preventing injuries (or any real proof), they cause serious damage! Plus, *if* you wrench your knee or snap the largest bones in your body, they have surgeries for that all day long. If you break your neck...it's pretty much the end of your life as you knew it. With that logic heavily on my mind, combined with a flurry of neck injuries, I made the decision to speak up about neck protection. I appreciate that people took it seriously, but it's not like I was saying you're stupid to go out there without one or that it should be mandatory, as some took it. My intention was for riders to be aware of it and for it to be considered.

"They aren't for everybody. A shorter guy like Ricky Carmichael isn't really built for one, but I felt he could certainly have some valuable input since he was wearing something similar in auto racing and wears Ernesto Fonseca's name on his jersey. I hoped companies would see the importance of developing protection for those funky rag doll crashes we all have at some point if you ride long enough. I simply looked at the brace, did my own research and quickly formed the opinion that it could reduce the magnitude of a neck injury more than it could cause any damage. It seemed very 'airbag/life jacket'-ish to me, and since I'm far more aware of life after a broken neck than most people, I felt a moral obligation to say something.

"The calls and emails about broken necks [that I was getting before the 2007 video] literally stopped after I did that video! Instead, I have heard many stories about people who bought a brace, wadded themselves up, broke the brace and had their doctor tell them, 'This thing probably saved your life!' Now, can hair splitters get involved and argue that it might in some cases not really work, or cause a concussion? Sure, but where is *that* proof? I'm glad something exists for those who choose to feel a little safer out there. I have nothing against a rider who opts not to wear one. I just felt it needed to be a piece of equipment that was on the radar and more considered than it was at the time I spoke my mind. I have come to the same conclusion as anyone else who has searched for evidence. If you feel comfortable with one on, wear it, because it will likely help you, not harm you in most cases. A lot of people assumed I got some sort of compensation for what I did back in February 2007. I didn't know anyone at Leatt and didn't receive anything other than a couple braces for my son Sean. What I did was from my heart.

"Having just watched Anaheim One, I believe Trey Canard's emotional and impressive comeback was made possible because he was wearing neck protection when a rider landed on his head. And I believe James Stewart's knee brace failed."

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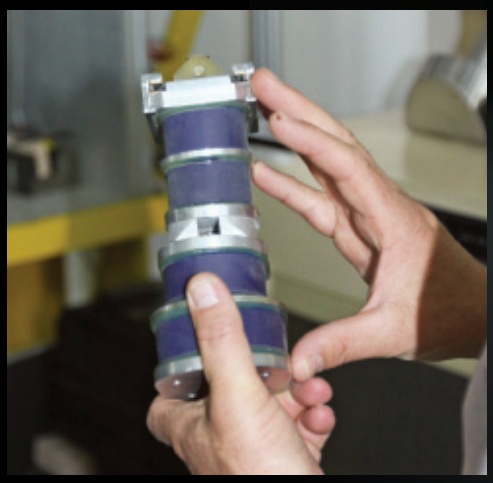
LEATT'S TESTING

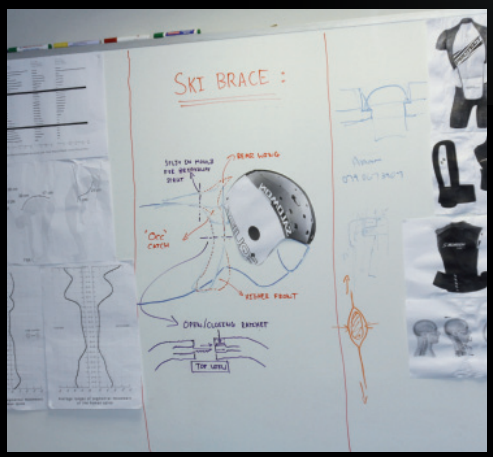
Leatt has been at work designing, building and using a test lab and software simulation program. The Leatt website hosts their white paper, a technology-dense journal of their procedures and some of their results. The short version is this—

The Dummy: The Leatt test dummy is a Hybrid III 50th percentile ATD (Anthropomorphic Test Device), fitted with an MATD (Motorcycle Anthropomorphic Test Dummy) neck. The "stock" dummy was designed mainly for car crashes, but with this neck, the dummy can test the different postures, off-center impacts and neck torque associated with unrestrained torso (motorcycle) crashes. The dummy is fitted with 29 sensors [4], and according to Dr. Leatt, "We usually record 23 at a time, plus the pendulum swing angle, impact velocity and video feed. The sensors record data at 10,000Hz (1 data point every 1/10,000 of a second). Per test run of 1.3 seconds we typically record about 2GB of data."



The Rigs: The dummy can't be thrown to the ground in a consistent way (and the sensor wires wouldn't allow it), so Leatt uses test rigs that stress the dummy with repeatability. The inverted pendulum test mounts the dummy upside down and swings it at various shaped and weighted blocks, which tip out of the way. The horizontal pendulum test rests the dummy on its back, chest or side, and swings an impact block against the head. Both tests allow changes to the impact shape, angle and surface friction. As Dr. Leatt explains, "These test methods allow for maximum loading of the neck to achieve maximum specific forces like compression, torque and shear in order to consistently 'overstress' the neck."

The Program: The physical testing informs and validates simulation software, which can create different types of motorcycle crashes in the virtual computer world so the Leatt team can get an idea of the forces on the rider during these impacts. Leatt also recreates, in the computer, actual real-world crashes where the medical results of the rider are known. In addition, the lab uses finite element analysis testing (or, more simply, strength testing each component of the brace) to study their products' structures and materials (to design the brace to break when and where Leatt wants it to), and TekScan (pressure mapping sensors) to analyze how the brace transfers the forces into the torso—duration, amount and over what area.



ALPINESTARS' RESEARCH

Alpinestars also conducted in-depth research into neck protection. The internal paper that Alpinestars created is not public like the Leatt white paper, but Alpinestars has permitted us to see some of the information. The company shared this statement on its initial observations, "Current test dummy neck constructions are very rigid in comparison with 'real' necks, and these do not permit a true evaluation of neck protection. Instead, the majority of the [Alpinestars] testing was simulated using a virtual model of a human created by an academic institution in the Netherlands. Alpinestars' results, which also encompass some research from cadaver testing, adds weight to the opinion that most damage is done in the first few milliseconds of an impact."

DOWNSIDE TO A BRACE—TRUTH OR MYTH?

There is some belief and concern that a neck brace can cause or increase injury in the event of all or certain crashes. To counter these theories and create more discussion, some more information from the Leatt lab deserves to be presented here.

The Strut Threat: Possibly the most-discussed perceived threat is the strut that rests on the rider's back with the Leatt and other brands' braces. Some people theorize that the brace could transmit and focus the forces from a crash onto the thoracic spine (middle back), or create a fulcrum around which the thoracic spine could hyperextend, thereby causing an SCI in the middle back when there otherwise might not have been one.

Or Not: The Leatt strut is there to keep the brace in its proper position during riding and a crash and to transfer force loads. Leatt designed its strut to break away before it could cause injury. This is where those SCI statistics (most from before braces were being used) that suggest the majority of SCI will be concentrated in the middle spine become very interesting, because even without a brace this is where spines statistically appear to receive the most SCI in motorcycle crashes [5].

The strut is designed to fracture at 300N (Newtons of force, which is about 67 pounds of force). According to Dr. Leatt, this is "One-thirtieth (1/30) the force allowed to be transmitted by a CE level 2 (the safest level) back protector." While at the factory in South Africa, I was handed a Leatt brace and instructed to break the strut by hand. I did, and would agree that it did feel like it took about 67 pounds of force, directed straight out away from the brace.

Note: Leatt has a new model streetbike brace that uses two smaller struts that rest on the rider's shoulder blades since some street jackets have an aerodynamic hump right in the way of the single strut, but Leatt doesn't recommend this brace for offroad riders because the motion of a rider's shoulder blades will constantly move this brace out of its ideal position.

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The "Tuck And Roll" Threat: That the brace would limit a rider's ability to "somersault out of a crash."

Or Not: According to Dr. Leatt, this is, "A big misnomer. If you look at gymnastic or movie stunt videos, you will notice that the 'tuck and roll' is performed over the shoulder and not the vertex of the head. In addition, it is unlikely that whilst being launched off the front of a bike, it is possible to bring your arms up and position yourself for a tuck and roll."

The Fulcrum Threat: That the helmet could go over the edge of the brace and bend the neck with more leverage.

Or Not: The Leatt's shell is designed not to allow a helmet to "reach" over it.

The "Force On Sternum" Threat: That a brace could create a dangerous chest-crushing injury.

Or Not: In the case of the Leatt, as demonstrated by the lab's TekScan tests, the forces are directed into the pectoral muscles which are better fit to absorb forces than the cervical spine.

The Collarbone Threat: That a neck brace will increase the rider's chances of breaking a collarbone.

Or Not: According to Dr. Leatt, "...with a finger on top of the collarbone and the arm raised and lowered, there is no pressure directed onto the collarbone by the brace due to the inclusion of a clavicle relief area..." The Leatt team explains that collarbones are very strong against downward force (as the brace would apply), and that in most cases the collarbone breaks in an upward direction from an impact to the shoulder, and on the opposite side from where the brace would be contacting with force.

The Laceration Threat: There was an Internet rumor about a rider in Sweden who had a brace shatter and slit his throat.

Or Not: Leatt neck braces are lined with padding. Leatt attempted to find evidence of this case, could not find any, and wound up with a letter from the SVEMO (Swedish Motorcycle and Snowmobile Federation) confirming there was no such case [6].

The Distraction Threat: The limit to the range of motion could cause a rider to crash when they otherwise wouldn't.

Or Not: The "feel" of riding with a brace is a subjective thing that each rider needs to try for himself. It should be said, though, that a brace must fit property to function properly and feel right. So a "test ride" with a buddy's brace should include fitting it properly to you.

THE TROUBLE WITH NUMBERS

It's very difficult to find medical statistics on SCI from off-road and motocross crashes; too many of the statistics are from streetbike crashes, and many of those don't even show if the rider was wearing a helmet. Also, many organizations that collect statistics don't release them publicly. Unfortunately for research purposes, neck brace effectiveness is not likely to have comprehensive medical statistics any time soon (the good news is, SCI is rare enough that there aren't quickly-building statistics).

There is also that concern that test data and research from a manufacturer is going to be biased toward finding a benefit to the product the company is selling. I made every effort to get independent eyes on the Leatt results, but from my research it seems the Leatt lab in South Africa is one of the few labs testing these types of neck forces. I toured the lab, and I was impressed. Dr. Chris Leatt and his team cooperated greatly for this story, and I believe genuinely want to get their findings out because they are confident all test information will show a benefit, and not a risk, to wearing their brace.

Alpinestars shared some of its research data and sources within its own research paper, "Catastrophic Neck Injuries in Motorcycling—Understanding How to Help." There is a difference in approach versus Leatt; however, it reaches the same general conclusions that a neck protection device can provide a benefit that outweighs any potential disadvantages.

AN ANSWER

That's a lot of gruesome medical scenarios and complex information to process. But with protection available, you owe it to yourself, or any kids you take riding, to examine the possible benefits of neck protection that is available today. From my experience touring the Leatt laboratory, and my research since then, including discussions with employees at Alpinestars and Atlas, the evidence available today leans heavily in favor of wearing a neck brace. In fact, not a single expert I spoke with (doctors and biomedical engineers) discouraged wearing a brace. But the best summation of all the data came from Dr. Leatt when he said, "We won't put anything on the market that I won't put on my own kid."

SPECIAL THANKS TO:

Dr. John "Doc" Bodnar, Dr. Amy McIntosh of the Mayo Clinic, Dr. Stephen Swisher of Mammoth Hospital, Dr. Terry Smith, Mr. Dave Halstead, Dr. Oswald Steward of Reeve-Irvine Research Center, Dr. Erik Swartz of the University of New Hampshire, Dr. Chris Leatt, the Leatt Laboratory crew, Phil Davy, Alpinestars' Neck Protection R&D Team, and Brady Sheren and Eddie Cole at Atlas Brace Technologies

WANT TO HELP?

THREE ORGANIZATIONS DOING GOOD THINGS TOWARD SPINAL CORD INJURY RECOVERY: WWW.WINGSFORLIFE.COM/EN/, WWW.REEVE.UCI.EDU AND WWW.CHRISTOPHERREEVE.ORG.